JOURNAL

OF THE

AMERICAN WATER WORKS ASSOCIATION

Vol. 27 DECEMBER, 1935 No. 12

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JOURNAL
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Vol. 27 DECEMBER, 1935 No. 12

EMERGENCY WORK OF THE DIVISION OF SANITATION DURING THE NEW YORK STATE FLOOD

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New York State's first major disaster and the events which transpired following it, are receding into the past. Now only the physical scars of this great flood remain, although it will be many years before some of these are obliterated.

Before the passage of time completely submerges this experience in the oblivion of forgotten events it is desirable that some record be made for posterity. There may be future floods and out of this story may come some suggestions that will prove helpful to sanitary engineers a generation hence. The story will never be told in its entirety. The part which engineers of the State Department of Health played in this emergency is only a small fraction of the total effort exerted in behalf of a stricken people, and even this cannot be told adequately. To the entire engineering staff of the Department the flood emergency offered an opportunity to demonstrate how it could respond and render service in a time of distress and the only claim made is that to the point of physical and mental exhaustion every effort humanly possible was exerted to protect the public health.

The threatened perils to health existent at the time did not mate-

rialize. No epidemics of disease followed in the wake of this catastrophe. As a matter of fact health conditions throughout the flooded area were notably better in July and August, 1935 than for the corresponding period in 1934. This record has been the subject of much favorable comment and regardless of the extent to which the engineers may have been responsible there is satisfaction in recalling that this condition was in reality the single definite objective toward which they worked.

In time of disaster general concern grips the people; fears are accentuated, and situations are viewed with alarm. At this juncture it is fitting to inquire into the reactions at the time and to weigh them in the balance of a calm judgment. Were there real dangers to the public health? Were conditions created favorable to outbreaks of epidemic proportions? Frankly from the beginning those fears were entertained and it was not until 21 days after the flood, notwithstanding the fact that the efforts had been as prompt and effective as possible, that there was complete reassurance. Fears were engendered in the first instance by lack of knowledge as to what had happened.

From the beginning it was appreciated that, as is true in any disaster, local authorities in stricken communities may suffer from "disaster shock." There is a time when the local health officer or the water superintendent for example may be dazed or preoccupied with other matters which take on exaggerated import at the moment so that he fails to "see the forest because of the trees." Further, as is true of all disasters, there must naturally be some lapse of time before the details are known to the outside world. Fears were somewhat accentuated when some of these details were ascertained. There is always danger of an epidemic when public water supplies are subjected to serious contamination by polluted flood waters. Favorable conditions for transmission of waterborne disease always exist when simultaneous flooding of private and public wells, privies, cesspools and sewage treatment plants occurs. These conditions and several others did at one time or another exist in the affected area. Sewage polluted water did enter several municipal water systems. In some instances local water authorities under stress of the emergency did fail to take precautions that would have been a matter of routine under normal conditions. Hundreds of private wells were flooded with sewage polluted waters. In view of the wide area affected, the large number of communities involved and the large population that

was suddenly forced to resort to water supplies of unsafe or questionable quality it was almost too much to hope for the favorable record that was attained. No single case of illness occurred in the entire region which could be attributed to a polluted water supply, either private or municipal.

The excessive rainfall preceding and the appalling damage resulting from this flood are probably the striking features that will be most remembered. The man-hours of flood relief activity have already been taken for granted and somewhat forgotten.

METEOROLOGICAL CONDITIONS

The peculiar meteorological conditions that combined to make this flood a reality are an interesting part of the story. They cannot here be described in detail but in brief the stage was set when on July 6, after a rather sluggish passage northeasterly across United States and Canada, an immense low pressure area was deflected by a cold air barrier moving southward, southeasterly across the Great Lakes, so that it centered over New York State. Three general air movements were involved: (1) the passage of a "low" eastward across Canada, beginning June 28 over Alberta, crossing Hudson Bay on July 4, and passing to Atlantic Ocean on July 5, (2) the passage of an immense "low" area northeasterly across the United States from Nevada beginning July 3, its merger with another "low" area moving southeasterly across Montana, over Bismark, South Dakota on July 4 and deflection of the movement of the combined "lows" southeastward along the northern shores of the Great Lakes on July 5 and 6, by the cold air barrier that had moved in following the Alberta "low." (3) The passage of another "low" pressure area beginning July 7 over Atlanta, Georgia, northeasterly along the Atlantic Coast. The "low" area centered over Cortland, N. Y. and was held practically stationary by the effective cold air barrier. An explosion of continuous and severe thunderstorms occurred resulting in the cloud bursts which took place on July 7 and 8. Apparently new rainfall records were registered. Unofficial reports gave rainfalls in excess of 8 inches in 24 hours and totalling nearly 15 inches over a three day period at some stations. The area affected by this heavy rainfall extended roughly from the Adirondacks to Pennsylvania and from the Catskills to the Alleganies.

Damage was naturally more spectacular in the hilly regions. In many places turf and soil was washed out to bed rock almost on the

very top of hills. The flood run-off poured down steep slopes and narrow valleys raising rivulets to raging torrents carrying with them trees, bridges, buildings and other obstructions. In many places where only shallow roadside gutters had previously existed deep gorges now remain. Dams along the streams gave way adding to the impact of the flood. Flat lands at the lower ends of these small valleys were buried with rock and debris, in some cases to depths of 10 feet. In some of the villages cars parked along streets were entirely buried with rock. Thousands of acres of fertile farm lands were destroyed. Only in the flat valleys as at Hornell and Binghamton did velocity of waters diminish sufficiently to produce the typical condition of inundation. In these areas the receding waters left a trail of damaged houses with basements flooded and floors covered with mud and silt. Houses were submerged in many places to attic floors.

DAMAGES TO WATER SUPPLY

The fury of the flood can be described somewhat by relating briefly the damage which a few of the public water supplies sustained.

At Delhi the filter plant was partially washed away. The 80,000 gallon settling basin was floated 1500 feet down stream. At Walton —The East Brook emergency pumping station, together with pipe lines at stream crossings within the village were washed out. At Otego a wash out in the main supply line left the village temporarily without water. Serious washouts occurred in the distributing systems of Lisle and Whitney Point, which were among the most severely stricken communities in the flood area. At Greene and Oxford main supply lines leading to storage reservoirs were washed out. At Newark Valley the pipe line crossing Owego Creek was washed away. The small supply line at Richford was washed out in many places. Wells of the Hillcrest water District and at Addison, Painted Post and Owego were flooded to depths of several feet. The sewage treatment plants at Corning and Ithaca were submerged. At Marathon the main supply line to the village was washed out. The spring sources of supply at Interlaken were flooded. At Cincinnatus lateral washouts occurred. At Hornell the lower reservoir dam gave way completely wrecking the two supply mains over a length of two miles; numerous breaks occurred also within the city. At Binghamton main supply lines over 2500 feet long laid in the bed of the river were destroyed. In addition the Susquehanna River at Binghamton

under the influence of the flood coming down the Chenango River reversed its flow causing grossly polluted water to pass upstream over the city's water supply intake.

Washouts occurred at Bath and Hammondsport. At Hammondsport flood waters in the lake put one of the pump motors out of commission and a further rise of 1 to 2 inches would have made it impossible to pump any water. Hammondsport was one of the communities that was virtually buried with rock, hundreds of tons being washed into streets and over yards and around houses to depths reaching 8 to 10 feet. At Arkport the spring supply was entirely buried with rock and the main supply line between the collecting reservoir and village washed out. This line had originally been laid along a highway leading to the village. After the flood only a portion of the macadam section of the road remained with a deep gorge along side with fragments of the pipe line in the embankment suspended fifteen to twenty feet above the bottom of the gorge.

At Watkins Glen due to numerous breaks which had occurred in the distributing system it was impossible to maintain pressures. Water lines were filled with mud and silt. At Montour Falls the main supply line leading from the filter plant was washed out. Washouts occurred at Trumansburg and several other places. Trumansburg was another community that was particularly hard hit. A considerable portion of the business section of the village was washed away by the raging flood waters. Damage of a proportionate nature occurred also in the smaller communities that were not served by public water supplies.

It was a matter generally of about 48 to 72 hours before it was possible for Department engineers to complete their check on all the public water supplies throughout the area which had been seriously affected. Hundreds of bridge and highway washouts had occurred making travel very difficult and uncertain. Some communities were completely isolated for a day or more. Telephone service had been disrupted and news was slow in reaching the Department.

The excessive rainfall which was responsible for the flood occurred on Sunday, July 7 and most of the damage was done late Sunday night and early Monday morning, followed by more rains and more washouts on Tuesday. First reports to the Department filtered in on Monday afternoon and by Tuesday morning it was fully appreciated that the State was in the throes of a major disaster.

FIELD ORGANIZATION

Several months earlier District Engineers had been established throughout the State, five of whom were in the area affected and were on duty from the beginning of the emergency. District State Health Officers with nursing staffs were also distributed thoughout the area. With this organization in the field supplementing the work of local health and water authorities the Department was fairly well prepared and did render effective first aid to stricken communities. This field force was rapidly expanded by the assignment of engineers and nurses, from other districts which had not been affected and from the Central office. The exodus began on Monday afternoon at a time when it was impossible to reach some of the communities and was practically completed on Tuesday. By Tuesday night the seventeen Department engineers in the field had been able for the most part to check the public water supplies in the most severely stricken communities and take the proper steps to assure the restoration of water service and the delivery of safe water. On Wednesday, Engineer Dappert became the last of the available staff to take to the field for flood duty, having until this time been occupied with assisting in the administration of the work from the Central Office, which was a necessary, though less dramatic, feature of the service.

The organization of the field forces and their distribution through the area was simple and effective. Engineers Bates and Bernhardt were rushed from Buffalo to Hornell Monday afternoon to take care of Steuben, Livingston and the eastern part of Allegany Counties. Engineer Riley was stationed at Ithaca to serve Tompkins County. Engineer Wagenhals from Syracuse was assigned immediately for service in Cortland, Cayuga and Seneca Counties. Engineer Holdredge at Oneonta was already on duty in Otsego, Scholarie and Delaware counties. Larkin at Middletown was rushed to Walton, and Bennett from the same office was available for service in Ulster County. Engineer Allen was assigned to Binghamton to supervise and coördinate the work in Broome, Chemung, Otego, Chenango and Tioga Counties and to assist him were assigned Engineers Cox, Kerslake and Zollner. Engineer Erickson was assigned to assist in Delaware County and later to Binghamton to assist in that area. Engineer Agar assisted by Schermerhorn of the Central Office and Kelly from the Division of Laboratories and Research was dispatched to take charge of the work at Watkins Glen and in Schuyler and Yates Counties. Engineer Schreiner at Ticonderoga was imme-

diately available for service in Washington and adjoining counties. Engineer Thomson at Amsterdam was assigned to look after Fulton and Montgomery Counties. With some minor adjustments and reassignments this was the organization and these were the men who bore the brunt of the Division's responsibilities in the flood area which embraced all or parts of twenty four counties. Excellent liason was maintained between field engineers and District offices and the Central Office. Frequent checks were made on the progress of work in each locality. It was possible to exchange information, deliver instructions and secure quick action on all matters requiring attention.

It is easily possible to summarize in brief order the general plan of the work, but it is impossible to give an adequate conception of what this work actually involved, the problems which developed and the many intricate and interesting details of the control measures which were applied. In the matter of checking over public water supplies alone and rendering emergency service in connection therewith it is surprising to note that by the end of the third day following the flood and in spite of difficult travelling conditions the field engineers had checked over the conditions of 93 public water supplies and had rendered aid in the case of 42 which had been damaged or washed out.

The protection to public water supplies, restoration of normal water service, services in connection with water supply emergencies—this was the first order of business. Washouts, many of them severe and resulting in the failure of water service, had occurred in 19 instances. The flooding of municipal wells and springs by high waters necessitating emergency measures had occurred in 23 communities, and in several the circumstances were such as to give rise to grave concern. Numerous breaks in water lines allowing the entrance of mud, silt and polluted water added to the public health hazards in most of the affected communities. To meet the public need and alleviate the dangers it was necessary to install or make arrangements for the installation of portable emergency chlorinators and emergency hypo-chlorite treatment plants in 16 communities. Many of these were installed by Department engineers. Existing chlorination and water treatment plants were checked and rechecked and no opportunity was overlooked to assure the delivery of safe water and to render aid of any kind. The work was done so thoroughly that by the end of the third day following the flood reports

from the field engineers received at Central Office gave assurance that there would be no epidemics attributable to infections of public water supplies acquired from that day on. It was clearly recognized, however, that real dangers had existed during the first two days of the emergency and the fears of an epidemic were not completely dispelled until sufficient time had passed to carry beyond the possible 21 day incubation period for typhoid fever. The absence of diarrhoea and gastro-enteritis, however, gave some indication on the third day following the flood that no particular difficulties were to be expected.

The wide gap between the creation of the definite health hazards through the failure and flooding of municipal water supplies and private wells and the application of proper control measures was effectively bridged by taking full advantage of the general concern that prevailed during the first few hours of the emergency. Warnings were issued immediately and repeatedly over the radio and through the press to boil all drinking water. These warnings were issued by the Governor, by the State Commissioner of Health, and by local Health Officers and the cry was taken up by lay persons in the affected areas and rebroadcast by word of mouth between neighbors and friends. It is amazing that these warnings could have been so effective. It is frankly admitted that the matter of boiling water was over done. In several communities boil orders were issued when subsequent checks on the public supplies showed that throughout the period the municipal water had been of safe sanitary quality. But the error was on the side of safety. Checks made throughout all counties of the flood area at the time indicated that these warnings were being taken seriously and as a consequence few people in reality were exposed to the dangers of drinking contaminated water. The effective response given by the inhabitants of the flooded areas to the warnings thus issued marked the first and most important barrier set up to protect the people against disease.

It was the alertness of local health officers in the first instance that made these warnings effective. Trained over a period of years to be on the look out for conditions of emergency the local health officers almost without exception responded immediately to the situation and employed every available means of communication to inform the residents promptly as to the necessity of boiling their drinking water. The warnings issued some hours later through press dispatches and over the radio by the State Department of Health and other central agencies of State Government added weight

to the warnings already generally issued by the local health officers and served to keep the people keyed to observance of the practice until normal conditions could be restored.

CONTROL OF PRIVATE WATER SUPPLIES

Public water supplies having been given the attention and service which their importance merited, work was then directed toward the disinfection of private wells which had been affected by the flood. The State Commissioner of Health secured authorization from the Temporary Emergency Relief Administration for a state wide project designed to make this possible. It became the function of the engineers to organize, supervise and carry on this work, which was started on the third day and practically completed on the tenth day following the flood. This work was started first in the small hamlets and centers of population and then extended into the farm sections. In some sections the work was carried on with personnel supplied by the Civilian Conservation Corps and the U. S. Soil Erosion Service. About 10,000 private wells were treated with strong solutions of chloride of lime. Few, if any, private wells throughout the wide flood region were missed. The work was accomplished for the most part by numerous truck details comprising crews of 6 to 8 men who worked simultaneously in the various valleys and sections as directed by Department engineers. These crews were thoroughly instructed as to procedures and there was no particular difficulty in having the work carried on efficiently, intelligently and completely.

Notwithstanding questions which might be raised as to the real value of these efforts it is believed that they were essential. Even in the case of driven wells where there is some doubt as to the efficiency of such treatment because of the difficulty of securing penetration of the chlorine solution into the water bearing stratum, it is felt that the energy expended was worth while. The program had been widely publicized and it was found that the residents generally were anticipating visits from these disinfecting details. It served to prolong the period during which time the residents would seriously adhere to the policy of boiling their drinking water. In many cases the treatments were effective in eliminating contamination introduced at the time the wells were flooded. The only real danger in the program was that it might develop a false sense of security in the minds of the owners with respect to their individual drinking water supplies. A single disinfecting treatment of a well subject to more or less continuous

pollution would be of value only as long as residual chlorine persisted, and in the case of driven wells the effectiveness of the treatment was somewhat questionable. These draw-backs were appreciated from the beginning and the program was undertaken as much for the purpose of educating residents as to fundamental requirements for safe well supplies as it was for the actual treatment of them, many of which were so located with respect to sources of pollution as to be unsafe for use under any circumstances. The disinfecting details were given a rudimentary knowledge of well sanitation in advance of their work. The men employed on this work were intelligent and were selected with these thoughts in mind. The dangers of nearby sources of pollution were pointed out to the owners of many wells. In some areas placards were placed on wells denoting that the water was unsafe or unfit to use without boiling. The purpose of the well disinfection program was carefully explained and the limitations of the work made plain. The psychological effect of this work upon people undergoing the strain of a flood emergency is worthy of serious consideration. The visitation of premises for the purpose of disinfecting private wells gave residents, at a time when most needed, assurance that no opportunity was being over-looked in the interests of their health and provided an opportunity of driving home lessons in sanitation that will have permanent values. Many of the well disinfecting details in connection with their work, were also employed in ascertaining cases of illness, accidents, and relief needs in families, which procedure greatly facilitated the functioning of other agencies.

GENERAL EMERGENCY WORK

Emergency work in connection with public water supplies and with the disinfection of private well supplies were the two matters concerning which the field engineers were given definite instructions. Assignment to flood relief duty, however, was with the understanding that services should be offered in any helpful capacity in furthering the interests of general sanitation and clean-up of the region. The work was to be organized and supervised in detail in sections where needed and in the areas where exceptional facilities existed for administration of this program or in areas where such work had already been effectively organized services were to be directed in seeing to it that the essential work was properly carried on. Thus, depending on the particular needs of each community and section the engineers' activities ranged from detailed direction of the work, involving super-

vision over payrolls and supplies, to assistance of a general and advisory nature. It did not matter how the work was accomplished so long as it was done. It embraced such matters as the following:

(a) Organization and Supervision over water delivery services in communities where water supply failures had occurred.
(b) Checking of public eating places to determine extent of compliance with "boil water" warning.
(c) Removal and disposal of dead animals.
(d) Supervision over temporary eating places provided for refugees and workers.
(e) Distribution of chloride of lime for premise disinfection purposes.
(f) Pumping and cleaning out of flooded houses and basements.
(g) Disinfection of basements using portable and truck mounted spray equipment.
(h) Disposal of refuse, debris from homes, and decomposing matter removed from basements.
(i) Sanitary surveys in small hamlets and rural sections and reporting of illness and relief needs.
(j) Liming and oiling of exposed mud flats.
(k) Oiling of streets and calcium chloride applications to control dust.
(l) Reconstruction and building of privies.
(m) Drainage of impounded waters.
(n) Transportation of people to typhoid immunization clinics.
(o) Sanitation of railroad labor camps.
(p) Investigation of nuisance complaints.
(q) Restoration of sewer systems and sewage treatment plants to normal operating conditions.
(r) Supervision over existing and emergency dumps and incinerators.
(s) Limited mosquito control measures in some communities.

It is impossible to catalog completely the variety of services which were rendered, but the foregoing will serve to illustrate the principal elements of the sanitation program that was carried out generally in most sections of the flood area. At one time more than 5,000 men were employed on these phases of the general, sanitation program.

COÖPERATING AGENCIES

Lest the impression has been created that the State Department of Health looked after all these matters to the exclusion of other

agencies of Government it will be well to point out a few outstanding general observations with reference to this flood experience that are clearly recognized by all who rendered service in connection with it. This flood marked perhaps the first time in history when the agencies of Government were adequate to administer promptly and effectively to the needs of a stricken people in a major disaster. From a health standpoint the State Department of Health through its district plan of organization was fairly well prepared to meet such an emergency and it was possible to supplement and reinforce this service promptly through assignments of additional personnel from Central Office and other districts. From a supervising standpoint the force was adequate to prescribe the essential sanitary services and emergency measures which should be carried on but the Department lacked entirely the man power necessary to translate advice into action.

This man power, however, was supplied through both the regular and relief agencies of Government—The Department of Public Works, The Conservation Department, The State Police, The TERA, Civilian Conservation Corps, the Transient Division of TERA, U. S. Soil Conservation Service and various organizations such as the American Legion and Veterans of Foreign Wars. The existence of a relative large disciplined force as represented by these various agencies and others, who were thrown into the flooded section immediately, makes this disaster relief experience stand out as a classic. At least to some of the engineers whose experience includes service in connection with major disasters which have occurred in other States, there never was an emergency that was met more promptly, handled more efficiently, nor which occurred at a time when there was proportionately as much labor immediately available for disaster relief purposes. These disciplined forces were employed on every phase of flood relief activity. Their work began with the rescue of people from flooded homes, and continued throughout the emergency period in innumerable ways. Some of them are still at work in clearing farm lands of debris and in other rehabilitation tasks.

What the Civilian Conservation Corps and the Transient Division of the TERA and other relief forces actually did for the flood sufferers will probably never be recorded in its entirety, but it can certainly be stated that no body of men ever applied themselves more energetically and unselfishly to the tasks at hand than did these men.

In some places it was found upon arrival that the essential general sanitary relief program had already been well organized and was

being efficiently administered. Here it was only necessary for the engineers to coöperate with those who had already assumed the burden of carrying on the work and to act in a general advisory capacity. In other places it was necessary for the Department engineers to assume detailed direction and supervision over all phases of the program. There was the closest of coöperation between the many agencies and especially the State and municipal agencies operating in the area. This orderly condition is attributed to both the unselfish spirit with which everyone connected with the work approached their tasks and to the plan of organization that was conceived and laid down by Governor Lehman. It had been his order that every Department of State Government which by reason of its interests and nature of its work could be of any help in the flood area, should respond to the fullest extent of its facilities. The flood area was divided into three general districts and a representative of the Governor appointed in each to coördinate the work of many agencies and departments. Each agency was represented on a Committee which met daily to discuss problems and find ways to meet them. It was across these Committee tables that answers to the problems of the hour were found and the speed and dispatch and lack of confusion with which the relief work was carried on bears testimony to the wisdom of this temporary organization.

The work of Department engineers and their anxieties in regard to water supplies were very materially lessened by the aid and coöperation which was given by local health officers, local water authorities, operators, superintendents and from outside sources. In the main local health officers and water authorities responded completely and as far as humanly possible to the public water supply emergencies. Some conditions unfortunately were beyond their control and it was in these situations perhaps that it was possible to render the greatest aid. No story of the flood relief work could be complete without acknowledging in the first place that it was the untiring and prompt work of local health officers and water authorities, superintendents and plant operators, that established the great barrier against the outbreak of epidemic disease.

HELP FROM AREAS OUTSIDE

From outside sources came material assistance also. Milk and oil companies and cities outside of the affected area promptly made equipment and personnel available for the distribution of water in

communities where service had been disrupted. Much outside assistance was provided also for such services as cleaning and sprinkling streets, removing débris, pumping basements and cleaning and repairing damaged water and sewer lines. The American Legion true to its name poured in as a Legion in some of the communities and performed exceptional service.

It is not possible to acknowledge here all the aid that was thus rendered but outstanding among this help was that which was extended to the Department by Wallace and Tiernan, Inc. This Company offered the services of its entire staff and the loan of as many chlorinators with men to install them as were needed. The Department made immediate use of this service and is greatful to this Company and to the men who were assigned to flood duty for the aid thus given which was urgently needed and extremely valuable at that time.

As an example of the speed with which this Company worked it is only necessary to point out the services of Peck who was enroute to Oxford to install a chlorinator within an hour after we had requested his assistance; or at Dundee where Keirn within twenty four hours after our request had a permanent chlorinator installation in operation.

The brief allusions previously made with reference to damaged water supplies give a rough picture of the extent and magnitude of the damage suffered but they do not give much hint as to the total effort and energy expended in meeting problems occasioned by these water supply failures. It is not possible to give these data in detail and all of it by no means is recorded in the files of our Department. However, it is possible to give some account of a few of the experiences that will serve to illustrate the type and general character of the problems encountered.

EXAMPLES OF DIFFICULTIES

The Department received word on the afternoon of July 8 that the water supply including the filter plant had washed out at Delhi. Our District Engineer could not reach Delhi immediately because the village was isolated by flood waters, but it was barely possible that it could be reached from Albany by a rather circuitous route. An engineer from the Central Office was accordingly dispatched to the village with an emergency chlorinator and after numerous difficulties he finally reached his destination at 11:00 P.M. As previously stated he found a portion of the filter plant washed away and the settling

basin 1500 feet down stream. Although the reservoir dam had been topped and considerable fill on the down stream side washed out exposing several feet of the main supply line, the reservoir and intake and pipe line were still intact and untreated water was flowing to the village. The Health Officer had been prompt, however, in issuing the "Boil Water Order" and posters throughout the village had been on conspicuous display for some hours. Before the emergency apparatus could be installed it was necessary to remove a section of the filter building roof which was in danger of collapse. But the chlorinator was finally installed and in operation within 24 hours after the damage had occurred.

At Walton most of the village was inundated. Washouts in the distributing system had occurred at stream crossings. A serious fire broke out from an explosion of gasoline floating on the surface of the water in a flooded basement at a time when about half the village was without water service. Upon his arrival the engineer checked the chlorine treatment as applied to the several sources and found the dosage somewhat inadequate at one plant which was promptly corrected. Temporary hose lines were laid where this was practicable to provide service to sections which had been isolated by the breaks. He supervised the systematic disinfection of the entire distributing system in the lower area which had been subject to contamination by flood waters, continuing this work until O-T residuals were obtained at fire hydrants. A detail of laborers from the State Highway Department was obtained and a water delivery service using 40 quart milk cans was organized to supply water to families in need of such service. By the fourth day following the flood about 90 percent of the service had been restored through construction of temporary lines, but it was July 14 before full service was finally restored.

At Otego the Department installed an emergency chlorinator to disinfect the distributing system which had been subject to pollution by flood waters due to a break above the village at a creek crossing. Heavy chlorination was continued until O-T residuals were obtained throughout the system.

At Montour Falls assistance was rendered in connection with the installation of an emergency pumping station which had to be used for three days before repairs could be made to a broken line that had isolated the filter plant. This temporary equipment provided a means of supplying heavily chlorinated muddy water until normal conditions could be restored.

An interesting side light is found in the experience in one community. For some years a by-pass had existed at the filter plant by means of which raw water could be supplied to the village in times of fire. The Department had always objected to the existence of this by-pass but had made no headway with local officials in securing its removal. The flood afforded an excellent opportunity to see this closed by-pass in actual operation. It was protected theoretically by two gate valves with a bleeder between them. Both gate valves were found to be leaking and as the elevation of the clear well was below the elevation of the valves there was a negative head on the by-pass line allowing raw water to enter the distribution system. The bleeder of course was of no value under these head conditions. The prompt elimination of this by-pass was secured.

In connection with the drinking water delivery arrangement at Montour Falls and Watkins Glen an interesting device was contrived. It consisted of galvanized iron watering tanks of several hundred gallons capacity used commonly on farms. At one end of the trough was a threaded plug to which a faucet was fitted thus avoding the necessity of dipping. The top was kept covered with a sheet. Treated water was transported in milk trucks from Horseheads and Rochester and in disinfected sprinkling wagons from Elmira and upon arrival was given an extra dose of chlorine to safeguard against possible contamination in handling.

No more spectacular situations developed than at Lisle where a main broke and Whitney Point where a large part of the distribution system was valved off because of a broken hydrant. The water supply of these two communities is furnished by a small water company the owner of which is a non-resident. The water superintendent lived in the path of the flood from Dudley Brook. His house had been badly damaged and the two automobiles which he used in his work were buried under rocks and mud and all of the water company's tools, including valves and wrenches, were swept downstream. The water main in Lisle passing under Dudley Brook was broken leaving Kinney Spring as a source of supply for a small section of Lisle and Cronin Spring as the source of supply for the remaining sections of Lisle and Whitney Point. During the flood a section of concrete side wall had smashed a fire hydrant and practically all of the water from Cronin Spring was flowing to waste. In order to shut off the water in the break at Lisle it was necessary to manufacture an emergency wrench which was accomplished at a local garage. When

this break was shut off about 100 homes were without water. In order to shut off the water at the broken hydrant it was necessary to close three valves leaving nearly one half of Whitney Point without water. The small reservoir on the system was completely drained.

Previous to the arrival of the Department's engineer it had been able to get assistance from outside sources and a chlorinator had been installed on the Cronin Spring supply. The functioning of this equipment was checked throughout the night. However, previous to this time an emergency well had been put into operation in the basement of a local garage. This well had been flooded to a depth of 15 feet and the well top was covered with mud. Its use was promptly discontinued as soon as the situation was discovered. By 9:00 P.M. it was definitely known that all water from Cronin Spring was safe for consumption, but there was an unknown amount of polluted water in some portions of the mains. In the early morning hours some of the fire hydrants in the section of Whitney Point farthest removed were opened in an effort to drain the polluted well water out of the system. Residual chlorine tests made at day break at the ends of the distributing system in both Lisle and Whitney Point showed sufficient O-T residuals to give assurance that the water was safe.

However, a small portion of Lisle and half of Whitney Point were still without service. There was no valve immediately near the broken hydrant. But necessity is the mother of invention. A few blows of a sledge hammer broke up the remaining portion of the hydrant leaving the hydrant valve stem exposed and a resounding whack of the hammer drove it down so that later when the water was turned on the leak was effectively stopped. By noon of the following day adequately chlorinated water was being supplied. With the assistance of the local fire department it was possible to bridge the gap in the broken pipe in Lisle by laying 1000 feet of fire hose from one fire hydrant to another, thus bringing into service the previously more or less isolated spring which had not been markedly affected by the storm and the water from which was considered to be of acceptable quality without treatment. A week later the main break was repaired, the new line disinfected and placed in service.

At Marathon the main leading from the springs to the village had washed out. The District Engineer from Syracuse was able to get there promptly. With some difficulty he was able to arrange for development of an emergency supply and the installation of an

emergency chlorinator. A fire pumper was used. The supply gave out in a few days and a second emergency supply was developed. Repairs were made to the main pipe line and the line including the reservoir were disinfected before being placed in service. The five individual springs of the regular supply were also treated. The first repairs to the pipe line were of a temporary nature and later it was necessary to return to use of the emergency sources for a limited period.

At Interlaken the village springs were flooded and arrangements were made to cut off the supply and draw upon previously stored water until chlorination could be arranged.

Probably no more acute public water supply difficulties developed than at Hornell and a brief résumé of the conditions in this city may be of interest.

The District State Health Officer who is stationed at Hornell woke up surrounded by flood waters. The water supply reservoir dam was topped about 10 feet and washed out. The two supply lines to the filter plant, a 16 and 20 inch, were washed out in several places and repairs were impossible until the waters subsided. The city in addition to being inundated was completely without water. Two engineers were rushed to Hornell from the Buffalo district and after some difficulties they were able to get through. A water delivery service with water obtained from a number of wells located at a local brewery which had a favorable analytical record, was quickly organized utilizing CCC and Transient Labor. As peddled, instructions were given to boil all the water thus delivered. Delivery was by trucks carrying 40 quart milk cans and this service was maintained for about 10 days. Some oil trucks were also employed.

Difficulties in bringing in an emergency supply of water at Hornell and making repairs to the damaged municipal supply were particularly severe. By July 9 it had been possible to develop a supply of 450,000 g.p.d. from a source used the year previous during the drought, by resetting some pumps, restoring power and connecting lines. This water was coagulated and chlorinated, but was insufficient in quantity to get service into any sections except in portions of North Hornell. By this time construction of an additional supply line from the same emergency source of supply was in progress and this was in operation two days later raising the available supply to 900,000 g.p.d. Due to previously undetected leaks and breaks in the distribution system at stream crossing within the city this was still

insufficient water to secure service even on the first floors of residences in Hornell. An additional emergency supply was brought into service raising the total to about 50 percent of the normal demand. Three bad leaks were discovered and either repaired or valved off with the result that on the fifth day following the flood some water was available at first floor taps in some sections of the City. By the next day through the further discovery and repair of leaks the City was getting fairly good service from the emergency sources of supply. The water was highly turbid, but never-the-less it was water and permitted use of toilets. The filter plant was purposely by-passed so that turbid water would be delivered through the system until an adequate supply could be developed as the fire hazard was extremely serious and every precaution to conserve water was essential. All water delivered, however, was heavily chlorinated at all times.

Many difficulties were experienced making repairs to the damaged supply lines. The 16 inch line was checked and recalked several times but when placed in service additional leaks and sags would be discovered necessitating repairs. This line was, however, finally placed in service on the ninth day after the washout and filtration of the supply was resumed. Engineers of the Department assumed general charge over the operation of the filter plant and were of service generally to the City Engineer in this capacity for several days. Extreme difficulty was experienced in the coagulation of the water. The raw water was extremely turbid and highly buffered. For a time over 5 grains of alum per gallon were required to effect proper coagulation. Fortunately the sanitary sewer system was not greatly injured. It was feared that many of the lines would be badly silted but only a few minor stoppages occurred and these were promptly corrected.

Later in the month heavy rain occurred which nearly resulted in the washout of the temporarily repaired main water supply line. By prompt action, however, 150 TERA laborers were rushed to the scene and a stone fill was made which averted the catastrophe. To have suffered a secondary washout at Hornell would have been the straw to break the camel's back. The people had been strained to the breaking point. On the last day that extremely turbid and heavily chlorinated water was distributed through the municipal system as a necessary conservation measure in the interests of fire protection, the general tenor of the people had reached a low ebb. The final restoration of the main supply line permitting the delivery

of an adequate quantity of clear filtered water the following day had strengthened the general morale in a real and tangible way. To have been forced to resume the emergency arrangements of the previous days would indeed have been a calamity. And no one appreciates this more perhaps than the City Engineer of Hornell who spent many sleepless nights and gruelling hours in applying his skill and knowledge to the requirements of the emergency and who suffered most from personal loss in the sudden death, attributable to strain of the emergency, of one of his most dependable and trusted employees in the Water Department.

It is with real satisfaction that the engineers of the Department look back upon this flood experience. Services were freely given and they seem to have been generally appreciated. Governor Lehman in a communication to the Commissioner on July 18, 1935 said:

"I should very much like to have the State workers in your Department know of my great appreciation of their services during the flood emergency. Perhaps there is someway in which my expression of appreciation may be made known to the members of your Department. I again want to thank you and your co-workers for the splendid, energetic and unselfish devotion to duty shown by all during the trying period of the flood. I have been greatly gratified to have had very convincing proof that State governmental agencies can act so promptly and so efficiently in an emergency."

These orchids were distributed to members of the staff through a special message from Commissioner Parran who said:

"The efficiency of an army is determined only by the test of war. The efficiency of any organization similarly can be tested by the way it deals with an emergency. The recent floods provided the emergency which tested the ability of State Health and other State forces to meet a serious menace. So far as I know, this flood was the first instance in which a major disaster of comparable extent was met and handled by the organized forces of Government. The efficiency with which representatives of the Department functioned throughout the flood area has been the subject of favorable comment by the Governor, by other Departments, by local officials, and the public generally. I want to express my very sincere gratitude to each of you who has contributed to this remarkable record of service."

A final bouquet was received from Deputy Commissioner Brooks who added:

"The various reports indicating that a good job was done came as

no surprise. It was expected. The Department had met serious emergencies before—polio in 1916, influenza in 1918—and its performances have always been creditable. The flood emergency was something new and different, calling for immediate and decisive action. With a minimum of confusion and delay the outfit went to work—The engineers under the command of "Colonel" Holmquist, bore the brunt of the work from the "word 'go'" and if there is no greatly increased incidence of typhoid they will be entitled to a big share of the credit."

LESSONS

No experience of this magnitude should be recorded without pointing out a few of the lessons learned and the sufficiency of measures which will prove most effective in future emergencies. The value of the Department's work would have been considerably enhanced by the receipt of prompt appeals for assistance from local authorities and prompt reports from communities as to actual conditions. Some valuable time was lost in ferreting out supplies which were in need of assistance from those which had not been materially affected.

In some of the communities where aid was urgently needed several hours delay occurred before the Department was aware of the difficulties and the assignment of engineers was correspondingly delayed. This situation can only be corrected by the gradual education of local authorities over a period of years to the point where they will react promptly in the matter of appealing for assistance. It is a situation that may be improved but perhaps never entirely corrected. Future emergencies, therefore, will be characterized by these initial delays and there will always be a certain definite period following these catastrophes when definite health hazards will exist and when conditions favorable to mass infections will be created.

It is well to recognize these contingencies in advance and barricade against them by issuing promptly general "boil water" warnings, utilizing the press, radio and every available means of publicity. To be effective the first warnings naturally should be by local health officers as time is of extreme importance. It matters not in times of emergency whether mistakes are made or not so long as the errors are on the side of safety. Warnings issued a few hours later by central agencies of Government will reinforce and emphasize the appeals already made and will serve to prolong the time during which local residents will seriously adhere to the policy of boiling water and

will afford an opportunity for engineers to swarm in over the public supplies and set them in order before the people recover from the general state of concern.

It is essential to reduce by every hour possible the delay incident to getting engineers to the communities affected. Travel difficulties of an almost insurmountable nature will present themselves but usually some way will be found to overcome them. It is expected that engineers assigned to such work will go without sleep until water supplies have been checked and action instituted to assure the delivery of safe water. In communities where water failures have occurred it is essential from the beginning to organize and supervise the delivery of water from approved sources.

Following any major flood the work of disinfecting private wells and related activities will form one of the essential elements of the relief program. Flood sufferers have come to expect this service and regardless of whether or not the efforts are entirely successful the work affords an excellent opportunity for health education and instruction in matters of sanitation that will have permanent values. The work should be undertaken with its definite limitations in mind and these limitations should be carefully explained as the work progresses.

In similar emergencies the public will entertain great fears as to the danger of disease from flooded basements, exposed mud flats, decomposing debris, etc. Actually there is little danger in these objectionable and somewhat obnoxious conditions, except possibly in the matter of fly breeding which may be encouraged in the stacks of vegetables and putrescible material removed from basements. Every effort should be made to allay these fears, at the same time giving adequate recognition to the aesthetic objections to such conditions and lending such efforts as are possible to restore premises and streets to a wholesome sanitary condition as rapidly as possible. In this connection the generous use of lime and chloride of lime is thoroughly justifiable for premise disinfection purposes. In such emergencies there is a definite need for reassurance to flood sufferers who are under considerable strain that every possible effort is being made to protect their health and add to their comfort. The liming of exposed mud flats, disinfection of basement walls and floors with chloride of lime, liming of piles of debris removed to the curb line, and similar activities which in reality have little specific public health values do have very definite psychological values and should be carried on.

The outstanding lesson learned from the flood perhaps is that there is definite need in New York State for undertaking a comprehensive program of rural sanitation primarily along educational lines. For many years the Department has sought by every means at its disposal to foster sanitary improvements in rural sections and no doubt these efforts have been successful. But enough work still remains to justify the expansion of effort in this direction. Facilities of the Department are limited at present but it is hoped in time that it will be possible to give attention to the problem of sanitation on farms and in small hamlets in proportion to the importance which this work merits.

(Presented before the New York Section meeting, October 17, 1935.)

THE COAST RANGE TUNNEL OF THE HETCH HETCHY AQUEDUCT

By Leslie W. Stocker

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The twenty-eighth day of October, 1934, will stand out in the chronology of San Francisco as one of the most notable dates in the city's history. On that day water flowing from a distant source in the Sierra Nevada through the Hetch Hetchy aqueduct was officially welcomed into the city's local water system. The Coast Range Tunnel, the final link in the aqueduct line, is completed and in service.

In this paper the purpose is to describe the design and construction of the last-completed division. A statement on the system plan and its evolution is, however, appropriate, so that the place of the Coast Range Tunnel in the aqueduct as a whole, and the reasons for adopting this relatively costly form of construction instead of one of lower first cost, may be clearly understood.

EARLY PLANS FOR THE HETCH HETCHY AQUEDUCT

The Hetch Hetchy region, in the high mountain area tributary to the upper reaches of the Tuolumne River, was suggested more than fifty years ago as a source of water supply for the City of San Francisco and the San Francisco Bay district. A map dated 1882 shows "the course of the proposed canal of the Tuolumne and San Francisco Water Co." In this plan water was to be diverted from the river at a point a few miles downstream from the site actually chosen, which is known as Early Intake, and was to flow thence in a ditch 44 miles to a reservoir at elevation 1000 feet, near La Grange, in the foothills east of the San Joaquin Valley. A line of 48-inch steel pipe, 125 miles long, was to extend from the reservoir to San Francisco. Another pipe line was included to supply the East Bay region, and a branch to Stockton and Sacramento was indicated. This was apparently to be a gravity system throughout, with a maximum head of about 800 feet in the San Joaquin Valley, and with a tunnel about four miles long through the highest part of the Coast Range.

The suggestion of the Tuolumne source appears in a report of the United States Geological Survey published in 1899, but without definite plans.

In 1902, C. E. Grunsky, then City Engineer of San Francisco, recommended the Tuolumne as the most available source for a greater water supply for the city. His plan was for an ultimate development of 160 m.g.d. with 60 m.g.d. initial development. The aqueduct was to be 182 miles in length, with 141 miles of steel pipe, 28 miles of open canal in the Sierra Nevada, and numerous short tunnels of 13 miles total length. Later modifications by Marsden Manson, City Engineer from 1908 to 1912, increased the proposed ultimate capacity to 300 m.g.d., and reduced the aqueduct length to about 170 miles, with 30 miles of tunnels. Both Mr. Grunsky and Mr. Manson planned to deliver the water by gravity at the west side of the San Joaquin Valley and pump it up the east slope of the Coast Range, using hydro-electric power generated along the aqueduct line in the Sierra foothills.

THE ADOPTED PLAN

In 1912 John R. Freeman, as consulting engineer to the City, proposed a plan for the ultimate delivery of 400 m.g.d., in which, by the use of long tunnels in both mountain ranges, he eliminated canals and their maintenance problems, increased the power development possibilities, shortened the aqueduct to about 152 miles, and lowered the grade in the Coast Range section to provide for gravity delivery to San Francisco, conserving power that would otherwise be consumed in pumping. The total length of tunnels proposed was 84 miles.

Definite planning for construction under M. M. O'Shaughnessy, City Engineer of San Francisco from 1912 to 1932, and Consulting Engineer to the Public Utilities Commission of San Francisco from 1932 until his death October 12, 1934, confirmed the merits of the Freeman plan, and the aqueduct now in service conforms in the main to that plan.

The most notable change in the scheme as a whole since the earliest plan is the increase in the ultimate quantity of water to be diverted to San Francisco, and the most outstanding points of difference as to physical features between the adopted plan and the earlier ones are the elimination of pumping and the use of tunnels of great length in the main aqueduct.

The introduction of the Coast Range Tunnel, 28.64 miles long, for gravity delivery led to a great deal of controversy. Some critics declared that the tunnel project could never be carried out because of the nature of the ground to be penetrated. Others, not so pessimistic as to physical feasibility, pronounced the tunnel plan economically unsound because of its greater initial cost. However, a comparative estimate, made shortly before work was commenced on the tunnel, resulted in the conclusion that the cost of a tunnel 10.5 feet in diameter, designed for a capacity of 200 million gallons daily as a part of the ultimate development, and capable of being operated at a higher capacity pending the completion of the ultimate scheme, would not materially exceed the sum of construction cost and capitalized operation, maintenance and depreciation costs of a pumping system of only 60 m.g.d. capacity. The tunnel cost has exceeded the figure used in that estimate, but if the present value of the future investment necessary for additional capacity of the pumping system be added, together with capitalized annual charges, the comparison still favors the tunnel.

THE CONSTRUCTED SYSTEM

The Hetch Hetchy system as constructed has two storage reservoirs, Hetch Hetchy and Lake Eleanor, of 67 and 9 billion gallons capacity respectively. Water from Hetch Hetchy flows in the Tuolumne River 12 miles to the point of diversion at Early Intake, the headworks of the main aqueduct, at elevation 2346. Water from Lake Eleanor flows 8 miles in natural channels to a diversion dam on Cherry River, and thence in a 4-mile aqueduct to Early Intake, where it too enters the main aqueduct. The fall now wasted in the stream channels is to be utilized later for power development. These reservoirs and diversions control a watershed area of 713 square miles, whose easterly boundary is the main ridge of the Sierra Nevada, and forms also a part of the west boundary of the Mono Lake watershed area, now being tapped to increase the water supply of Los Angeles. The joke about Los Angeles extending to meet San Francisco has become a fact as regards water supply.

From Early Intake the main aqueduct extends 137.5 miles to its west terminus at Crystal Springs Reservoir on the San Francisco peninsula. The direct connection from this point to the City, about 17 miles, included in the Freeman and earlier plans, is left for future consideration. The aqueduct includes 65.9 miles of tunnels and

70.8 miles of pipe lines (not including duplication where pipes are parallel), 0.6 mile in two small regulating reservoirs, and 0.2 mile in open canal at the Crystal Springs outfall. The system is designed for an ultimate delivery of 400 m.g.d. The tunnels and pipe lines from Early Intake to the east side of the San Joaquin Valley (37.7 miles) are built for this full capacity, and the other units will be paralleled as increased capacity becomes necessary until the ultimate is reached. Additional reservoir storage in the mountains will be required for the full development.

THE COAST RANGE TUNNEL

Location and length

The east portal of the Coast Range Tunnel, known as Tesla Portal, is on the west side of the San Joaquin Valley, seven miles south of Tracy. From this point westerly the line passes seven miles south of Livermore and Pleasanton, and terminates at Irvington Portal, two miles northeast of the town of Irvington. The tunnel is interrupted by the valley of Alameda Creek, which is crossed by a pipe siphon, so that actually there are two tunnels. The easterly one is 25.20 miles in length, and is the longest tunnel ever driven. The westerly section is 3.44 miles long.

Designed capacity

The tunnel is designed for a capacity of 200 m.g.d. when operating under the hydraulic grade conditions of the ultimate 400 m.g.d. system. In the acquisition of right of way and in the arrangement of shafts and underground working chambers provision was made for the construction of a second tunnel parallel to the present one, to raise the aqueduct capacity to the final figure of 400 m.g.d. The second tunnel will not be required for many years, and the economics of the situation favored the adopted scheme rather than the immediate construction of a larger tunnel for 400 m.g.d. flow.

The tunnel is to operate under pressure. This will permit working the tunnel somewhat beyond the capacity of 200 m.g.d. already mentioned, by adding sufficient pipe line capacity west of the tunnel to reduce temporarily the loss of head in the pipe lines and make a greater head available to force water through the tunnel. In this manner it will be feasible and probably economical to use the tunnel up to 250 m.g.d. or even more, by tolerating a temporary loss in the pipe line capacity, the postponement of construction of a second

tunnel making it worth while to make an addition to the pipe line capacity for that purpose in advance of the time when such an addition would otherwise be necessary.

Grades

The tunnel is concrete-lined, with circular waterway 10.5 feet in diameter. The slope of the hydraulic grade line for a flow of 200 m.g.d. is 0.29 foot per 1000 feet, based on C = 120 in the Williams-Hazen formula, which corresponds in this case to n = 0.013 in Kutter's formula. The slope of the tunnel invert is 0.5 foot per 1000 feet (0.7 in the most westerly section), being made steeper than the hydraulic grade line to improve drainage conditions during construction and to permit temporary use for heavier flows by the expedient mentioned above. With 200 m.g.d. flowing, the tunnel will be under a pressure head of 41 feet above invert at the east end and 77 feet at the west. The east portal invert elevation was determined so that, with an initial flow of 60 m.g.d., the hydraulic grade line, projected back from its elevation of 393 feet at the west portal, reaches the east portal at approximately invert elevation, thus giving the maximum possible fall in the pipe line east of (upstream from) the tunnel. A higher portal elevation would reduce the pipe line capacity; a lower would unnecessarily add to the pressure head on the tunnel when flowing full and under pressure.

General design of lining

The thickness of the concrete lining varies from 10 inches to 3 feet within the neat line. The minimum occurs in a few short sections in hard rock, where timbering was unnecessary. The average nominal or effective thickness is 24 inches, and the average volume of concrete is 3.3 cubic yards per linear foot.

For several hundred feet in from each portal, the concrete is reinforced with steel. Each reinforced section extends well past the point at which the hydraulic grade line intersects the ground line.

Overflow shafts

At Tesla Portal and the two Alameda Creek Portals, overflow shafts five feet in diameter are provided, primarily to limit the internal pressure to which the tunnel lining may be subjected in case of stoppage of flow through the tunnel while water is still entering the tunnel from the east. Water rising through the shaft flows over a circular

weir at the top and is conducted down the hillside through a pipe, at Alameda East or West, or in a lined canal at Tesla, to the natural watercourse at the base of the hill. These shafts serve also as air vents or inlets when the tunnel is being filled or emptied.

Pipe line connections at portals

At each portal a section of steel pipe 10.5 feet in diameter is imbedded in the tunnel lining and carried out a short distance into the open. The adjoining pipe line branches off from the 10.5 foot pipe, and other branch openings will be provided in the future to accommodate parallel pipe lines. The outer end of the 10.5 foot manifold pipe section is closed with a dished head of the full pipe diameter, riveted into a cast steel flange bolted to a companion flange on the pipe. This permits the maximum convenience of access to the tunnel should a major repair operation ever be necessary.

The manifold at Irvington Portal is spherical, 14 feet in diameter, with three 6-foot branch openings. This was preferred at that location on account of space limitation.

Working points

The tunnel between Tesla and Alameda East Portals is divided into six sections by five shafts. The entire tunnel west of Alameda Creek was driven from the two portals. Thus there are in all, seven sections and 14 headings, four from the portals and 10 from the shafts. The distances between working points vary from 2.9 to 5.3 miles. The distances driven in individual headings vary from 0.75 to 2.95 miles.

Power for construction

Electric power for construction was distributed over 22,000 volt lines to all working points from a 6000 k.v.a. substation on the City's 110,000 volt Moccasin transmission line. All construction plant and machinery were electrically operated either directly or through the medium of compressed air. Storage battery locomotives were used for underground haulage.

Shafts

The five construction shafts range in depth from 301 to 823 feet, including 50 to 65 feet below tunnel level for rock pocket and sump. The shafts were, in general, timbered as sinking progressed, but in

some parts it was found advisable to line them with concrete at once. All are now concrete-lined throughout. Each shaft is rectangular in plan, 6 feet 9 inches by 20 feet in gross dimensions outside of timbering, and divided into three compartments, two for hoisting and one for pipes and manway.

The arrangement of the shafts with respect to the tunnel is unusual. To permit the future use of the shafts for construction of a parallel tunnel about 175 feet south of the present tunnel, they are located midway between the two tunnel locations, so as to communicate with both tunnels through a cross-cut. At each end of the cross-cut is a Y curving east and west into the tunnel. A stub of the future south tunnel was constructed extending in each direction about 60 feet from the cross-cut and used for shop space and for charging storage batteries of electric locomotives. On completion of construction the legs of the Y leading into the north tunnel were plugged with concrete. A cast steel manhole with an opening 6 feet square provides for access to the tunnel from the shaft. A rock-pocket was constructed beneath the floor of the cross-cut, and the excavated material from the headings was dumped from the cars into this pocket and then drawn off through gates into the skips for hoisting to the surface, avoiding the necessity for hoisting loaded cars, and permitting mucking and hoisting to go on at unequal rates.

Tunnel construction

The tunnel penetrates all classes of ground from quicksand to a trace of granite. In general, it is in soft sandstone, crushed shale, and crushed schist formations, and in much of the distance the ground is very heavy, necessitating extreme measures to support it after excavation. A squeezing action, which might be from any direction or all directions, was frequently encountered. This sometimes, where the sides and roof were adequately supported by timbering, caused the rising of the bottom of the tunnel and necessitated re-excavating the bottom repeatedly to lower the track by a total of several feet, the maximum total lowering being 8 feet. Such ground was hardest to hold shortly after initial excavation. It might crush the heaviest timbers, requiring retimbering two or three times, and then become stable and give little or no further trouble.

A few short sections, up to about 200 feet long, stood without timbering for years, from the time of excavation until lined with concrete.

Nearly all timbering was done as shown on figure 3, using vertical posts and segmental arches. The lightest timbering was of 8 by 8 inch sets spaced 7 feet center to center, and the heaviest, 18 by 24 inch sets at 24 inches.

Usually, in heavy gound, 12 by 16 and 16 by 16 sets were used, 5 feet center to center, and additional sets were placed between these later if the pressure developing made them necessary.

After costly experience with displacement or crushing of timber, the engineers decided to try lining the tunnel in very heavy ground

FIG. 1. GUNITE LINING IN TUNNEL NEAR THOMAS SHAFT

The man is making a precise measurement of the diameter

with gunite immediately following excavation, without timbering except for such lagging, crown bars and breast-boards as were necessary to hold the ground long enough to permit the concrete to take a substantial set. This proved very successful and was continued until excavation was completed, gunite being placed sometimes in rings a few feet long, and sometimes continuously for hundreds of feet. Cement developing high early strength was used for this purpose, and the set was further accelerated where necessary by adding calcium chloride in the proportion of 3 percent of the weight of cement. In this way a compressive strength of 1000 pounds per

square inch was attained in three or four hours, and over 3000 pounds in twenty-four hours.

Lining

The gunite lining already mentioned is in general 15 to 24 inches thick, with an extreme thickness of 36 inches, and a minimum thickness of 8 inches. On account of the high cost of gunite as compared with poured concrete, it was only placed in such thickness as necessary to hold the ground until regular lining operations. In general space was left inside the gunite for a poured concrete inner shell not

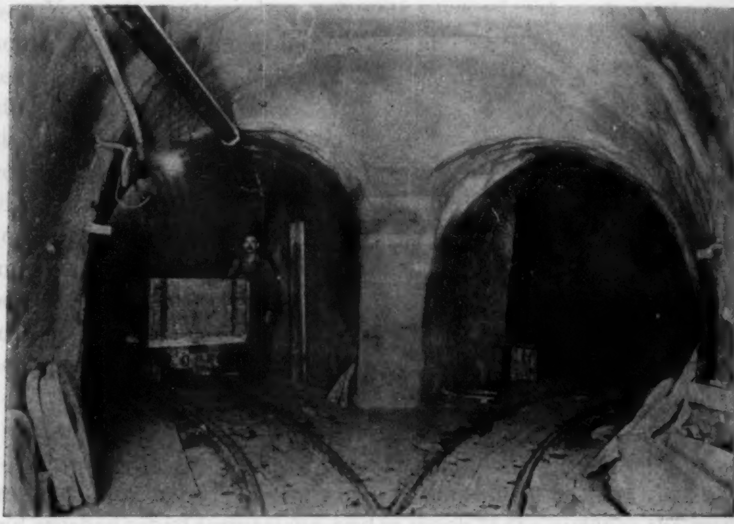

FIG. 2. VIEW FROM CROSS-CUT AT INDIAN CREEK SHAFT, SHOWING JUNCTION STRUCTURE

Main tunnel extends to right and left passing behind central pier

less than 9 inches thick to improve the factor of safety and to provide a smooth inner surface.

In some parts of the tunnel, however, the entire lining is of gunite, the originally placed gunite being finished later with a layer of gunite about 1½ inch thick, troweled to a smooth surface.

There are three classes of lining, as follows:

	feet	miles
Poured concrete for entire thickness of lining......	104,573	19.80
Gunite with poured concrete inner shell...........	36,370	6.89
Gunite with thin surface finish..................	10,288	1.95
Total..	151,231	28.64

The total volume of lining is approximately 500,000 cubic yards of concrete, of which about 135,000 cubic yards is gunite.

The gunite contains 10 to 12 sacks cement per cubic yard of concrete. Tests showed a compressive strength of 6,000 pounds per square inch, and upwards, at the age of 28 days. A few test specimens made from blocks cut out of the gunite lining several months old gave strengths of 8,000 to 10,000 pounds per square inch.

Poured concrete was placed in the invert by chutes from the mixer, and in the sides and arch afterward by pneumatic guns. Three

FIG. 3. TUNNEL NEAR INDIAN CREEK SHAFT

Note condition of heavy timbering at left

central batching plants were used, one at Alameda Creek, one at Valle Camp, and one at Thomas Shaft. Sand and gravel were prepared and stock-piled long in advance of concreting near these three points. Cement and aggregates in proportioned dry batches were loaded into special cars and hauled a maximum underground distance of 7 miles. The concrete gun, the mixer, and a ramp up which the cars were run to dump into the mixer formed a train running on the tunnel track. The invert concrete was screeded to the required circular arc. Steel forms were used for the sides and arch. The forms were vibrated during placement of concrete.

The concrete mix was in general designed for a 28-day strength of 3000 pounds per square inch. This required $5\frac{1}{4}$ sacks of cement per cubic yard in the invert, and 6 sacks per cubic yard in the sides and arch, the difference being necesary on account of the difference in the method of placement, and the greater amount of water required in the pneumatic process.

Before concreting was commenced a survey of the entire section to be concreted was made, and the condition of the timbering noted. The results of this survey were used to determine the necessary strength of concrete lining at all points. Where it appeared that 3000 pounds concrete would not give the necessary strength without shifting timbers to provide additional thickness of lining, the cement content was increased so as to give 4000, or even 5000 pounds strength. During excavation tests had been made to determine the loading on timber segments in place in various conditions of apparent stress up to incipient failure. Studies of ground pressure had been made over long periods of time, based on measurements of the deflections of concrete test rings. These tests gave the foundation for inferring the necessary strength of lining from the conditions found on the final timber survey. There have been no failures of completed lining.

After the placing of the concrete the final step in lining was the grouting behind the lining, through holes or pipes set for that purpose during lining. Besides filling the spaces that inevitably remain unfilled outside of the concrete in the upper part of the tunnel, the grouting sealed off most of the water entering the tunnel from the adjacent ground, but it is not expected that all such inward leakage will be stopped.

Construction difficulties

Besides the general ground conditions already mentioned, the most serious problem of construction was the handling of gases encountered in the tunnel. Hydrogen sulphide entered the workings at a few points, and at first was quite troublesome, as a very small quantity of this gas seriously affects the eyes, and may cause temporary blindness. Methane gas was the chief danger. Air containing 5 to 15 percent methane is an explosive mixture. The usual safety regulations of the United States Bureau of Mines require that methane be held down to a maximum of 0.25 percent. To keep within this maximum it was necessary to provide an unusually large volume of

air in the tunnel ventilation system, 4000 cubic feet or more per minute in each of the gassy headings, so as to provide the proper dilution. Fortunately the methane usually occurred in pockets which, when tapped, rapidly drained out, so that progressive additions to the tunnel ventilation equipment were not necessary. Despite all the usual safety precautions, an explosion occurred in the tunnel July 17, 1930, in which twelve men were killed. This led to the introduction of still further safety regulations, including the discontinuance of fixed electric lights in gassy sections, and the substitution of cap lamps, the introduction of "permissible" electric

FIG. 4. CONCRETE MIXING PLANT IN TUNNEL NEAR THOMAS SHAFT

locomotives, and other electrical equipment, the use of "permissible" explosives, and changing the ventilation from blowing to exhaust. One man of the engineering force was assigned to devote all his time to safety matters, fire bosses were employed on all shifts, and rescue crews were organized, provided with first-class equipment for all conditions, and kept in training by frequent drilling.

At a point about 4000 feet west of Indian Creek Shaft, the excavation broke into a quicksand deposit. The sand and water rushing into the tunnel filled it almost completely for one-half mile, and the sand was carried back as far as the shaft. After removing the sand

from the tunnel, another flow occurred, which, however, was of comparatively small volume. No further attempt was made to drive through this formation until about eighteen months later by which time the ground had drained out so that it was readily enough handled by driving a small drift, and then widening out and removing the bench.

High temperature and humidity made working conditions very unpleasant in the later part of the work when the warm air coming from the surface and traveling considerable distances to the heading

FIG. 5. PORTABLE GRAVEL PLANT

Used at three different locations to prepare sand and gravel for concrete

picked up moisture on the way. Toward the last men were working in air at 85° with 100 percent humidity. Temperatures much higher occurred during the concreting operations, due to the heat generated by the setting of the cement.

ORGANIZATION

The Hetch Hetchy Water Supply work, up to 1932, was in charge of M. M. O'Shaughnessy as City Engineer of San Francisco. In 1932, a change in the city charter placed the Public Utilities Commission in authority over all water supply, power, and other utilities

of the city, and Mr. O'Shaughnessy was appointed Consulting Engineer to the Commission. L. T. McAfee was made Chief Engineer and Manager of the Hetch Hetchy work. Leslie W. Stocker is Chief Civil Engineer at the headquarters office, and Carl R. Rankin is Construction Engineer in charge of the work in the field. All Coast Range Tunnel construction has been performed by day labor.

(Presented before the California Section meeting, October 26, 1934.)

WEED GROWTHS IN RESERVOIRS AND OPEN CANALS

By G. E. Arnold

(Water Purification Engineer, Water Department, San Francisco, Calif.)

Many American cities are today spending large sums of money to develop water resources, storage being an integral part of most systems. Some cities have abundant water supplies close at hand, requiring but little storage. To those water systems whose source of supply is distant and who must, therefore, in the interests of safety, store large volumes of water near at hand, or whose local systems involve impounding reservoirs, this subject of weed growths is of particular interest.

The use of copper sulphate to control algal growths is a standard practice of long standing and is a familiar procedure to many water works men. The use of chlorine for disinfection is entirely reliable and comparatively simple. The processes and purposes of filtration and aëration are well known, but the matter of the control of weed growths is a subject not well known and not thoroughly understood by those who have studied it. In most cases the growth of weeds in reservoirs used for domestic water supply is not particularly objectionable other than that weeds create an unsightly appearance; but there are several cases on record of weeds imparting a taste and odor to the water. In a few instances weeds and moss have impeded the flow of water, causing canals to overflow or plugging up outlet structures. Methods of weed control are still in the experimental stage and due to the complexity of the subject a reliable, universal method of accomplishing this end has not yet been devised. The destruction of weeds by the use of poisonous chemicals cannot be used where domestic water supply is involved, because of the danger of poisoning the water.

The water supply for the City of San Francisco covers a multiplicity of conditions and provides an excellent laboratory for a study of this subject. The City is now completing its Hetch Hetchy project, bringing to the City an ultimate capacity of 400 m.g.d. from the

high Sierras, two hundred miles distant from the City. Within a distance of fifty miles from the City impounding reservoirs are located with storage totaling 65 billion gallons. These reservoirs lie at elevations below 700 feet, located in a fairly warm region and are particularly subject to weed growths. The system is not equipped with filter plants and in most cases the water is drawn directly from reservoirs below the surface, being conducted through a closed pipe system directly to consumers or to distributing reservoirs. Chlorination is effected as the water leaves the storage reservoirs with secondary chlorination in some instances, at the outlet to open distributing reservoirs. Copper sulphate is applied to storage reservoirs, as needed, to control algal growths. These are the only forms of treatment regularly applied to San Francisco water.

WEED GROWTHS

For the purpose of this paper, weeds are defined as those aquatic growths which have a root system, or attach themselves to reservoir bottoms, or other objects in the water, thus differentiating weeds from free floating growths or plankton.

Conditions of weed growth vary considerably with changing environment. Water temperature is one of the important factors. At temperatures of forty to fifty degrees Fahrenheit weed growths will be slight, except for hardy plants whose growth is noted the year around in temperate zones. At temperatures of fifty to sixty degrees growth will become more prolific and will reach a maximum at water temperatures above sixty degrees. Different types of weeds prefer different water depths. Lily pads grow in water depths of 10 to 20 feet, sending stems to the water surface and spreading leaves over the surface. Potamogeton and Myriophyllum prefer depths of 2 to 5 feet, some varieties growing entirely submerged and others coming to the surface, spreading their leaves on top of the water. Some plants have only the floating leaves, others only the submerged, while several species have both kinds on the same plant at the same time. Some types grow with the roots and stem entirely submerged, but if the water recedes will continue to grow on the dry soil, others die as soon as the water recedes from the roots. Some varieties of weeds, such as Chara, grow in water depths from a few inches to as much as 12 or 15 feet, depending on the clarity of the water, the clarity governing the penetration depth of the light. This weed grows close to

the bottom spreading a fine mat of leaves and stems on the reservoir bottom.

Wind velocity is a factor governing weed growth. Most weeds will not grow extensively in a reservoir subject to much wind, as the waves thus created tend to wash and tear the plants, in some cases uprooting them.

The soil composing the reservoir bottom is an important factor governing weed growth. Most weeds prefer a silty loam soil or sand, but some varieties will grow in heavy clay. Many impounding reservoirs receive a deposit of silt from the incoming water, which is conducive to weed growth. In some cases, weed growths have been observed on rocky slopes and in loose rock fills on the face of dams, the weeds growing in patches of silt deposited between the rocks. An experiment has been conducted in the San Andreas Reservoir of the San Francisco system by placing a layer of clay in one section of the reservoir where weed growth had been particularly heavy, the clay bed being placed during March, before weed growths started. The growth of some varieties, such as Chara, were entirely eliminated by this method, but some other weed types, notably Potamogeton and Myriophyllum, continued to grow, although somewhat diminished in numbers. Weed growths will be less prolific on steep reservoir banks than on flat slopes.

Some weed varieties, such as Cladophora, will grow only in moving water, other types only in comparatively still water. Lemna will grow in still or slowly moving water, but not in flowing streams. The Lemna, commonly known as Duck Weed, spreads a mat of fine leaves over the surface of the water, sometimes so dense as to resemble a lawn, the water being entirely obscured.

The chemical composition of water has a decided effect on weed growth, but not within the limits of most water supplied for domestic consumption. In a few cases the chloride content of water is sufficiently high to retard the growth of cultivated lawns and gardens where the water is used for irrigation. This water, when stored in open reservoirs, produces very little weed growth.

Growing weeds consume carbon dioxide and liberate oxygen, increasing the dissolved oxygen content of the water accompanied by a rise in pH value. Decaying weeds contribute to the organic content of water, often increasing the chlorine demand and producing a taste in the water. At one time, while weed growths were particularly heavy in the San Andreas Reservoir, a chlorine dosage of 70 pounds per million gallons was entirely reduced.

TASTE DETERMINATIONS

A determination of the taste producing qualities of weeds growing in water was conducted at the laboratories of the San Francisco Water Department. Samples of all the varieties of weeds growing in the reservoirs were planted in large pans and their growth cultivated while passing a small quantity of water continuously through the pan. Periodically the water was tested for the presence of taste and odor. Portions of the weeds from these experimental beds were placed in other pans and submerged with tasteless water, previously passed through carbon filters. In several of these secondary pans the water was allowed to flow slowly through the pan and in others the pans were merely filled and allowed to stand. Part of the pans were placed under glass and part exposed to the atmosphere. In all cases, except one, the water flowing through the pans failed to acquire a detectable taste or odor, the exception being the water flowing through the pan containing the weed Chara, which, after contact with the plant, had a slight woody taste. In the pans in which the water was allowed to stand without circulation, a taste was developed in most cases within a few days, the tastes varying from woody to bitter in character. The pans containing the weed Chara developed a typical woody taste within a few hours. The weeds placed in the pans covered by glass died within a few days and imparted a strong taste and odor to the water. The death of the plants was probably due to the glass cutting off the ultra violet rays of light and the intensified taste and odor to the lack of air circulation to carry off the gases produced. The growth of algae became quite heavy in these experimental pans and frequent applications of copper sulphate were necessary to keep the weeds and water clean. There was no apparent change in the taste of the water before and after these treatments.

From these experiments it was concluded that the weed Chara does produce a noticeable taste and odor in water in which it is growing.

There are several varieties of this weed and not all of them have taste producing qualities. One variety growing in the Pilarcitos Reservoir did not produce a detectable taste.

The Chara is a small weed growing entirely submerged and close to the bottom of the reservoir. Around its short stem are whorls of fine leaves. The plant and roots are very delicate and easily broken, for this reason the plant is difficult to pull or rake.

TASTE AND ODORS

For three consecutive years much trouble has been experienced from this growth in the San Francisco system. This weed growth occurred particularly in San Andreas Reservoir, one of the principal storage reservoirs, located on the San Francisco Peninsula, ten miles south of the City. This reservoir lies at an elevation of 450 feet and has a storage capacity of 6 billion gallons. It is provided with two outlets located near opposite ends of the lake, each serving separate portions of the City.

The first year a musty taste and odor was noted at the north outlet, persisting for about two weeks, when it cleared up following a change in weather conditions. At this time 3 billion gallons of water were in storage and the taste affected only a portion of this. Changing winds probably mixed the water sufficiently to dilute the affected portions. Chara growths were confined to the northern-most part of the reservoir at this time.

The following year the trouble recurred, this time more noticeably than before and affecting both outlet supplies. At this time 3.5 billion gallons of water were in storage and a heavy growth of Chara was evident throughout the reservoir. The suddenness with which the taste appeared was believed to be occasioned by the stage of growth of the weeds. At this time the weed drops its spores and subsequently the taste producing qualities are developed. No change in the chemical quality of the water has been noted at this stage other than a gradual increase in dissolved oxygen and a rise in pH value. A heavy treatment of copper sulphate was made at this time as a precautionary measure, though plankton net samples disclosed no objectionable algal forms. No improvement in taste was noted following this treatment. The copper sulphate did, however, remove from the weeds a gelatinous mass of algal growths which had been clinging to the submerged plants.

In an attempt to overcome the objectionable taste, aëration of the water was conducted by pumping air into the water as it flowed through the forebay at the south outlet from the reservoir. This treatment produced no apparent results. At the same time experiments were conducted in the use of activated carbon. Two small pressure filtering units were constructed using granular activated carbon as the filtering medium. A fine carbon grain was used in one unit and a coarse grain in the other. Using a three foot depth of carbon it was found that one hundred and twenty gallons per hour

per square foot of carbon bed could be passed through the filters with excellent taste removing results. After three weeks of operation the carbon lost its taste removal effectiveness, the coarse grain carbon being the first to lose its adsorptive powers. Upon opening the filters it was found that the carbon particles were coated with fine sediment, filtered from the water. During this time the water had carried a turbidity of about 10 parts per million. A primary sand filter was then constructed and placed in operation ahead of the carbon units. This primary filter, a pressure unit of small capacity, was effective in removing most of the suspended matter from the water, permitting the carbon to work effectively. Shortly after placing this primary filter in service the taste in the raw water cleared up, but at that time the carbon was successfully removing the objectionable taste. The units have operated continuously now for more than a year and periodic inspections have disclosed very little sediment on the carbon particles.

The use of ammonia and chlorine was tried, but produced no improvement in taste, due probably to the raw water having a taste which was not accentuated by chlorination. Super and de-chlorination were also tried without beneficial result.

Soon after the taste appeared in the reservoir, the lake level was lowered eight feet by stopping the pumping into the reservoir. This uncovered 80 acres of bottom, most of which was overgrown with Chara. The exposed weeds soon died and the uncovered area was thoroughly burned over, using kerosene torches with a compressed air blast to produce a scorching heat. It was hoped that by burning the exposed weeds while the reservoir was at a low level, the spores would be destroyed and upon bringing the water up to a high level the burned area would be sufficiently submerged to prevent re-growth the following year. Unfortunately, the following winter was a dry one in the Bay region and insufficient rain fell to bring the reservoir up to a high level. The third year there was some recurrence of growth, but confined to the north end of the lake and the taste persisted for only a short time, affecting only the north outlet.

The application of powdered, activated carbon directly to taste affected reservoirs has been used in a number of places with apparent success, notably in several small water systems in Pennsylvania. In each instance it has been possible to take the reservoir out of service for a time until the carbon settled. As the San Andreas Reservoir could not be taken out of service, it was felt that the application of

carbon directly to the reservoir entailed some hazards from increased turbidity and the deposit of carbon in the distribution system. The application of two parts per million of powdered, activated carbon to the San Andreas Reservoir would have necessitated the use of 55,000 pounds of carbon, the uniform application of which would have been very difficult.

Some water systems, equipped with filters, have successfully applied activated carbon to the water ahead of the filters, the carbon being removed on the filters, but as the San Francisco system is not equipped with filters, this method of taste removal could not be used.

Laboratory tests have indicated that either of these methods would be successful in removing this particular taste from the San Francisco water, requiring two to three parts per million of carbon. As no successful method has been devised for the use of carbon in this system it appears that the only means of combating this taste problem is by controlling the weed growth.

CANAL GROWTHS

There are a number of canals and flumes carrying water between reservoirs on the San Francisco system. In the early days the Spring Valley Water Company constructed redwood flumes, roofed over. As these flumes have been replaced in recent years, concrete lined, open canals have taken their places. No growths of weeds or moss have been noted in the covered flumes, but the open canals have developed quite a growth of moss and water weeds. The variety, Cladophora, was the most troublesome growth, producing long strings and mats on the bottom and sides of the canal. It has been observed that the growth does not occur under narrow bridges or other obstructions to direct sunlight.

The writer observed a number of irrigation canals in the tropics, notably in Honduras, Central America, where weed growths choked the flow of water in unlined canals. Several of these canals were later lined with asphalt to lessen seepage losses, after which it was observed that weed growth was very much diminished. The same phenomenon was observed in concrete lined canals in the San Francisco system where tar and asphalt used in expansion joints was spread over the adjoining concrete, preventing the growth of moss.

There are probably two contributing factors to this phenomenon, the smooth surface of the tar or asphalt provides few recesses in which the weeds may root and the black surface may absorb sufficient

light to retard growth. Finishing the concrete lining of a canal with a smooth surface will aid in preventing growths.

At times canal growths may become extremely troublesome. One concrete lined, open canal in the San Francisco system produced such a heavy growth of Cladophora that the canal overflowed while carrying only 25 percent of its rated capacity. The growth of Cladophora may occur very rapidly at times. One canal in the San Francisco system after being scraped and brushed clean of all growths and sediment produced a heavy re-growth of this weed in three weeks. An adjoining section of the same canal, further downstream, was cleaned in a like manner, but treated with a small dose of copper sulphate applied continuously. This section produced no re-growths.

Experiments have been conducted in the use of copper sulphate to prevent canal growths. Intermittent application of this chemical was found to be ineffective even when used in high concentrations. A device was designed and placed in operation feeding a small dose of copper sulphate continuously. By experimentation it was found that the application of one pound of copper sulphate per million gallons of water was effective in killing weed growths present in the canal, as well as in preventing new growths. A killing effect on the weeds is first noticed after the application of copper sulphate, and after a time portions of the dead weeds break loose and float along with the water. New growths are prevented. This inhibition of growth has been effective throughout the full five mile length of the Crystal Springs Aqueduct. Recently some of these canals have been covered, eliminating all growths.

WEED CONTROL

It has been our experience that the prevention of weed growth in reservoirs is a difficult matter. The control of growths may, however, be exercised. Covering a reservoir to the elimination of direct light will prevent practically all weed growths. In open reservoirs, where the volume of water in storage is changed once or more in twenty-four hours, weed growths may be controlled to some extent by the application of copper sulphate with the incoming water. Using a copper dosage of two pounds per million gallons of water, some weed growths have been killed and new growths prevented. Where the volume of storage is large, or where the water in sections of the reservoir does not change frequently, the control of weed growths by this method is more difficult, as copper sulphate loses its effectiveness

within a few hours after application. Intermittently dosing a reservoir with copper sulphate produces little or no effect, even when used in high concentration, but continuous application does produce a desirable killing effect. Some varieties of weeds require such a high concentration of copper sulphate as to render the water dangerous for human consumption. The killing of weed growths already maturing in water is not always successful with the use of copper sulphate, but the prevention of new growths is often accomplished by this means, provided the application of the chemical is continuous and reaches all portions of the reservoir within a few hours.

The cutting and pulling of weeds growing in water is probably the most effective means of controlling their growth. Some types of weeds can be readily pulled or raked from the water, but with some types raking is almost impossible. Tall weeds that grow above the water surface, such as cat tails and tulle grass, can be cut at or below the water surface and raked out. Some types, such as Potamogeton, lilly pads and Myriophyllum, that grow only to the surface, can be removed with spiked drags pulled along close to or on the bottom. Other types, such as Chara, that grow close to the bottom, are difficult to remove with rakes or drags.

Burning over the exposed shores and bottom of a reservoir, while the water is low, has a beneficial effect in retarding weed growth, but is not altogether preventive, as some weeds grow from seeds or spores that are transported by the water and the burned over areas are apt to be re-seeded by the rising water.

It has been observed that weed growth is more prolific in reservoirs that are maintained at a uniform depth. If a reservoir can be kept at a high level during the spring and early summer and then rapidly lowered ten feet or more in the late summer, the weed growth will be left dry, whereupon it will quickly wither and die, after which it can be burned. A slowly receding water level will frequently permit weed growth to flourish ahead of the receding water. Quickly raising the water level will often drown out weed growths.

A reservoir lining of concrete or brick will frequently prevent weed growths, unless the water carries a high turbidity, which, if deposited in the reservoir, will provide soil for roots. Asphalt or tar lining may produce the same results as concrete or brick, but care should be exercised to prevent the imparting of phenol compounds to the water with attendant bad tastes following chlorination.

Stripping the top soil from the sides and bottom of a new reservoir

will often diminish weed growth. The top few inches of soil contain fertilizing material conducive to growths. Stripping an old reservoir may diminish growths, but stripping would involve moving much material if there were a silt deposit in the reservoir. Placing a clay lining on the bottom and sides would probably reduce growths, but in a reservoir subject to much wave action, the clay may be difficult to keep in place.

The continuous application of copper sulphate to the incoming water to a reservoir aids, not only in keeping down weed growths, but is also a preventive to the development of algal forms. Since the incoming water to San Andreas has been thus treated, the number of copper sulphate treatments applied to the whole reservoir have been reduced to one-third their former annual number.

In a few instances other chemicals than copper sulphate have been used to control weed growths, but the results have not been altogether successful. Some chemicals impart a detectable taste or color to the water and some are dangerous to use in a domestic supply. The use of chlorine is not satisfactory, as a sufficient dose to kill weeds would be difficult to obtain and practically impossible to maintain in stored water. The use of ammonia and chlorine in combination is not successful, as the ammonia provides nitrogen, which is conducive to weed growth.

CONCLUSIONS

Weed growths present a serious problem to the satisfactory operation of a water system where open reservoir storage is used. One of the best methods of controlling growths is by varying the water level. Another method is that of burning exposed reservoir banks when the water is low, or that of cutting and raking weeds from the water. The continuous application of copper sulphate is satisfactory for use in canals or small reservoirs, but is not altogether successful when used in large reservoirs.

If weeds impart a taste to the water, the best method of combating it is with activated carbon. Aeration may also help.

The subject of weed control is one of interest to water works men and is worthy of further study and experimentation.

(*Presented before the California Section meeting, October 25, 1934.*)

CONCRETE COATING FOR PIPE AND THE WILSON MACHINE

By Sterling C. Lines
(Consulting Engineer, Los Angeles, Calif.)

There came to my office several years ago crude sketches of a machine for extruding an encasement of concrete on pipe, the thought being that some such machine might introduce an improved method of applying concrete to pipe, and at a very low unit cost. The theory of operation was that through the application of great grinding pressure concrete might be made to stick to the pipe in a dense, uniform, intimate manner, sufficient for all practical needs in field operation. This meant that the design of machine and the extruding action had to permit of movement of machine on the pipe as result of pressure on the green annular ring of concrete, without injury, as it was deposited. In other words, the machine would move, because of reaction to the continued process of extruding, and only through such reaction.

Several years have been spent in the study and building of such a machine, until today it may be said to meet every important requirement in low cost operation and simplicity of design and construction. While concrete, as an encasement material in pipe protection, is not being applied generally, there is no apparent reason why its use should not be encouraged, referring particularly to permanent or semipermanent pipe lines subject to soil stresses, corrosion and/or electrolysis. In fact the A. P. I. and A. G. A. tests indicate clearly that concrete should be more widely used.

The machine is a very simple mechanism as shown in figure 1. A light steel frame is supported on the pipe by dollies; on the frame is mounted a small gasoline engine which actuates a revolving drum and cone; a housing encompasses the cone, concentric with and surrounding the pipe, with a hopper for receiving the concrete. As the screw on the revolving cone surface forces the concrete from between the outer surface of the pipe and the inner surface of the housing, the machine is compelled to yield to the reaction of the thrust, backing away from the completed coating as it emerges. It is only after

the coating or encasement has been extruded to a density able to resist the increasing pressure of the machine that motion to the machine is imparted. Hence, there is automatic regulation of concrete density, and the operator may be sure that he cannot successfully apply a worthless coating.

The interesting question answered by the successful operation of this machine was: "Could concrete be made to adhere to the lower arc of a horizontal pipe to the degree necessary for practical handling in the field, while sustaining the pressure necessary for movement of the machine?" We find that the concrete on the under side is the densest, most uniform, and it is surprising the amount of abuse it

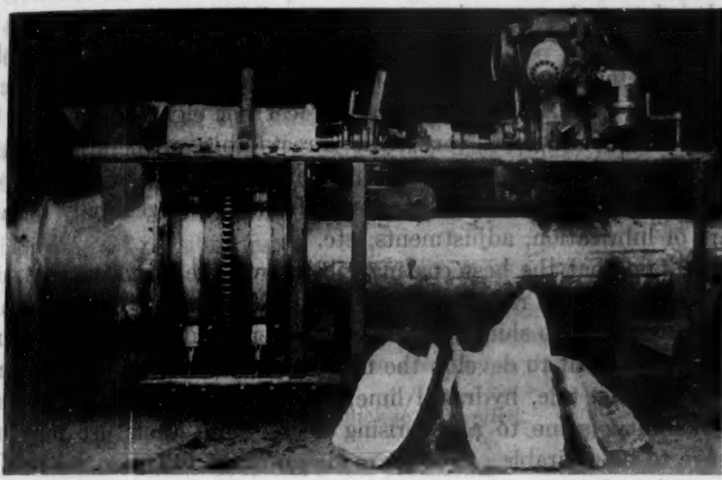

FIG. 1

will suffer without damage. If put on properly it is an excellent job of encasement; if not put on properly it will not adhere to the pipe.

In this we see the importance in deposition of grinding, rubbing, pressing contact with the pipe surface. If the least film of air or moisture remains on the pipe there is no close contact and the job fails.

If, on the other hand, the proper contact is made, one can take liberties with the fresh coating. In field work, with continuous operation, the pipe with fresh coating can be placed immediately after deposition upon suitable cradles, without appreciable deformation. At such points of support we advise wrapping the concrete

with waterproof paper over a length of several feet, as a precautionary measure. Hence, it is entirely possible, so far as the machine is concerned, to place several thousand feet continuously and at a rate of four feet per minute.

The question of speed is naturally an important one. We find that relatively high speed may be attained. Hence, that which will best meet the field problems of supply of materials, handling of pipe, etc., should lead to lowest unit costs. In our studies to date we believe that about four lineal feet per minute, for smaller pipe sizes is a suitable speed. This should permit doing a thousand feet per day, with generous time out for the many duties incident to pipe handling in the field. The crew should not exceed five men.

It is interesting to conjecture as to possibilities of low unit costs in yard operation. With pipe and concrete immediately available, the concrete flowing automatically to the machine as it travels backward and forward, several thousand feet per eight hours could be easily done, and with very little direct labor. Operation of the machine itself requires but one man, his duty being to steady it on the pipe and to see that it moves uniformly, and generally to take care of lubrication, adjustments, etc.

We find that the best coating job follows the best concrete mix. The water-cement ratio is all important. There can be no tendency of the concrete to slump, and on the other hand sufficient moisture must be present to develop the necessary workability. Admixtures of crystalline talc, hydrated lime, bentonite, etc., tend to increase workability (some to a surprising degree) but their use may not prove to be desirable. Yet we made no effort to cover this field of research and pass no final comment at this time. Suffice to say that the best concrete will yield the best result, careful attention being given to the water-cement ratio. We like the result from a mix, by volume:

1 cement
1.5 graded sand
2.5 roofing (pea) gravel
0.5 to 0.6 water cement ratio.

We have used up to 4 parts gravel and 2.5 parts sand. However, it is our observation that it would be questionable wisdom to depart to any appreciable degree from the above mentioned mix. The slight gain in cost of materials by any such departure would not justify the attendant risk of quality of final encasement. In every case the pipe, if needing protection, is entitled to the very best mix.

In the course of experimentation, coating thicknesses ranging from $\frac{5}{8}$- to $1\frac{1}{2}$-inch, have been applied, apparently with equal facility and resulting in the same character of concrete. At no time has there been evidence of segregation, cracking or spalling, irrespective of concrete proportions and water-cement ratio. Just what the ultimate capacity of deposition as to thicknesses might be has not been determined. A minimum of $\frac{1}{2}$ inch and maximum of 2 inches are indicated as limits of machine capacity in this regard.

The necessity of quick handling of the machine in the field has been fully recognized and the operation of locking the few parts together on the pipe is a matter of a few minutes only. The trained crew will have no difficulty in coating ten or more separate portions of a pipe line as part of a day's work. They will find no difficulty in following the line up-hill or down-dale and in negotiating curves of very short radii.

No discussion of this kind is complete without some reference to unit costs. Frankly, since experience background in operation is lacking, we cannot venture definite figures of cost. Much will depend upon conditions to be met. It is necessary however that we at least indicate cost possibilities:

Assume:

Welded 8-inch pipe in fairly level terrain raised 8 inches in the trench.

Pipe is roughly clean (no sand blast or close scraping needed)

Conditions will permit machine to coat in lengths of 200 feet without interruption.

Concrete encasement one-inch thick to be applied.

Five men form the crew.

Machine operates at rate of 3 feet per minute

180 feet per hour

1080 feet in 6 hours

allowing 2 hours for contributive work.

Materials:

Cost of concrete, 1000 feet, 8-inch pipe: 2200 square feet, 1-inch thick (2200 × 2.5 cents)	$55.00
Machine maintenance and depreciation	15.00
Total	$70.00
(or 7 cents per lineal foot)	

Labor:

Crew 5 men	$25.00
Overhead	25.00
	$50.00
(or 5 cents per lineal foot)	

Total cost $120.00, 12 cents per lineal foot, or 5.5 cents per square foot.

While these figures are low there is no apparent reason why, under average field conditions, they should not be met. They serve to portray cost possibilities as seen by those who through several years of interesting and difficult study have had to do with the development of this interesting machine. This machine is designed for hard, field service. There are no delicate parts or adjustments to make, ordinary repair can be effected in the country blacksmith shop and any ordinary crew of men can learn to operate it within a very short time.

THE MUNICIPAL WATER SUPPLY OF PARIS[1]

By John B. Hawley

(*Consulting Engineer, Fort Worth, Texas*)

Further development of water supply was resumed after a lapse of about four years, with Belgrand as Chief Engineer. His staff included men whose names, like his, will live in water supply annals: e.g., Prony and Bazin.

The Somme-Soude project was examined in greater detail, and abandoned in favor of underground and spring waters in the "Marne-Chalons" neighborhood, 70 miles easterly from Paris, and requiring a slightly shorter aqueduct.

The valley of the Vanne had been studied by Belgrand for several years, and now, with more authority and more funds, he and his staff entered upon intensive studies of the region, geologically and hydrologically.

The studies of the Vanne territory culminated in a firm decision and report recommending the use of the water bearing sands southerly from Fontainbleau as the principal source of water supply for the City. Plans were approved in 1861 and construction started in 1864.

Hydrological records showed that the Vanne had been least affected by all droughts. Its head is in the Department of Aube at Fontranne, near Estissac, nine miles from Troyes, in the "Cretaceous" Valley between the latter and Sens. At Estissac it receives its first two surface influents.

In passing it may be stated that all the underground waters of the Paris aqueducts are derived from sand strata of the Cretaceous Period, (Upper and Lower) or from the lower sands of the Eocene germane to the "Carrizo Springs" formation in Texas. Practically all these "spring waters" as the French call them, are in chemical content quite like those of similar formations in Texas, soft and agreeable to the taste, and nearly sterile as to pathogenic bacteria.

[1]Continued from The Journal, August, 1935.

Quoting Col. Georges Bechmann "the four sources of underground water supply of Paris are: The Dhuis, Vanne-Loing-Lunain and Avre (valleys), with filtered river water from plants on the Marne at Saint-Maur and at Ivry on the Seine, when the spring waters are temporarily insufficient."

Col. Bechmann's book, "Assainissement de Paris" was published in 1900, and his statements were doubtless correct as of that date, but today the filtration plants are in constant operation, furnishing about 50 percent of the total daily supply. The St. Maur filtration-

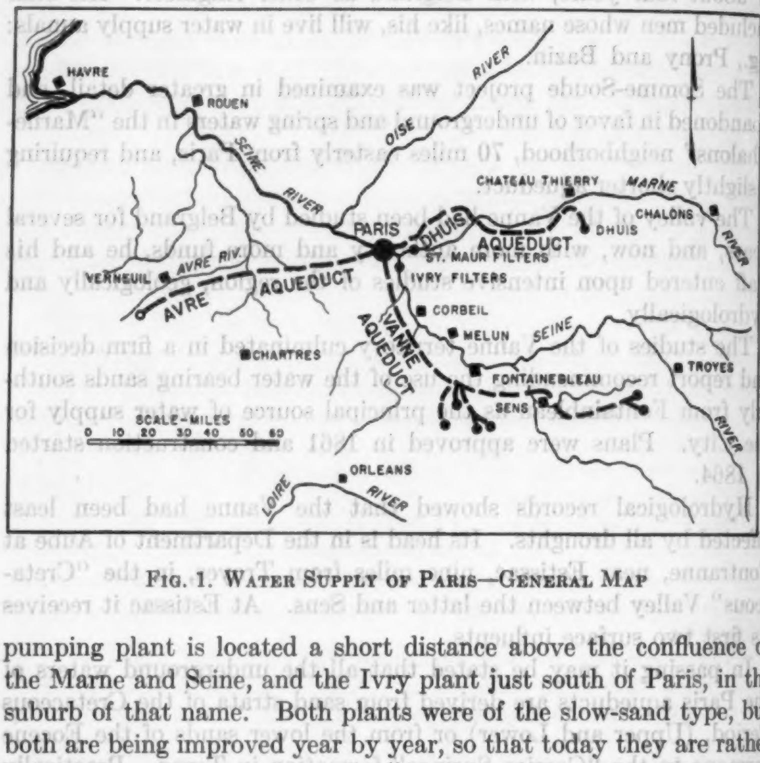

FIG. 1. WATER SUPPLY OF PARIS—GENERAL MAP

pumping plant is located a short distance above the confluence of the Marne and Seine, and the Ivry plant just south of Paris, in the suburb of that name. Both plants were of the slow-sand type, but both are being improved year by year, so that today they are rather difficult to define; the old "sand-scraping-sand-washing-sand-replacement" process is being gradually supplanted, in fact has been largely replaced, by "jet-washing" that is, by injecting filtered wash water (into the sand-beds) under pressure, through a ¾-inch pipe perhaps four feet in length acting as nozzle for a 1-inch hose, manipulated by a laborer, and by the remodeling of many filter beds

which now somewhat resemble "rapid sand" beds with combined collector and wash systems on their floors. The Ivry and St. Maur filtration plants are rated at about 76 m.g.d. each, but as improved are probably nearer 100 m.g.d. each.

"Javel water" has been more or less replaced by the "Verdunization" process (first installed at Verdun during the World War), of Bunau-Varilla. This "Verdunization" process has been adopted by many cities, including Paris. The inventor charges no "royalties." The two Paris filtration plants are also equipped with apparatus for "American" chlorination, with dosing apparatus and cylinders of liquid chlorine.

By the way, only a few of the French water and sewer engineers and managers have been outside the borders of their native land. I found none who had English, American or German books on his shelves, and but one, now Chief Engineer of Bridges, Highways, Rivers, etc., Monsieur Jean Parmentier, has visited America to inspect our works and methods. He spent two months in the United States, several years ago, and being blessed with a linguistic brain, acquired in addition to his University studies of English a fairly good grasp on our vernacular, which statement indicates that with my "very sorry" French, we got along quite well on our several inspection trips and in various interviews at his office.

The chemical content of the Marne and Seine waters is quite like that of the Mississippi, the Trinity (Texas) or of the average American river.

The main "Vanne" conduit is about 110 English miles in length and varies in diameter from 6½ to 8¾ English feet. The Dhuis conduit is 82½ miles long and of slightly less diameter. The Avre conduit is 64 English miles in length and averages about the same as the Dhuis conduit in diameter.

All these works are what we may well call "up-to-date," as Belgrand lived till 1878, seeing the Vanne supply brought into Paris in August, 1874; his successors followed "Belgrand methods" in the design and construction of the other aqueducts.

All have three types of construction: (1) underground plain and reinforced concrete pipes; (2) those carried on "arcades" some of which are of 3 "stories" like those of ancient Rome, and (3) "inverted siphons," these last usually carried on "one story" arcades, though some are underground, or underneath water courses.

WATER CONSUMPTION

Monsieur Frederick Diénert, for 28 years in charge of the purification of Paris' water supply, told me in October, 1932, that the usual (average) water consumption was 378 liters per capita per 24 hours, divided about 50/50 between the underground sources and filtered water from the St. Maur and Ivry plants, and exclusive of the "non-potable" water from the Ourcq canal.

The "spring waters" and filtered waters are delivered to consumers through the same pipe system. (It happens that the 378 litres per capita is almost precisely 100 U. S. gallons.) Ourcq water comes to the low-lying streets through its separate pipe lines (every hydrant or hose nozzle thereof bears a large sign, "Non-Potable").

RESERVOIRS

The several sources of supply are well provided with "receiving" and "service" reservoirs: (*a*) Vanne-Loing-Lunain waters are received by the Montsouris Reservoir near the south city line; (*b*) Dhuis waters enter the east city limits at the Menilmontant Reservoir; (*c*) Avre water arrives at the St. Cloud (or Montretout) Reservoir, west of the Seine and of the City proper. In addition to these three there are the "service" and "high service" reservoirs on Montmartre, in Passy, not far from the Trocadero, and several minor reservoirs.

The water levels (full) of all reservoirs vary considerably, those of greatest elevation being served by "booster" pumps. Capacities are ample to cover all variations of demand.

The "reseau" or pipe system, seems scientifically (and admirably) designed, and honestly constructed. The great sewers of Paris, especially in the "Right Bank," carry a considerable percentage of the large cast iron water pipe, 20- to 48-inch, on brackets, or corbels, or suspended from their arches. All "fire-hydrants" are underneath the sidewalks, set in what looks quite like an American cast iron meter box.

During Belgrand's time, underground water, coming to the surface, was first developed at Artois, in northeast France. In the years 1834–1841, before he was placed in charge of all water supply for the City, a well about 8 or 10 inches in diameter had been drilled into sands similar to those of Artois, at Grenelle, in the southwest part of Paris.

Col. Bechmann says of other noted artesian wells in the City: "At the time the Bois de Boulogne was transformed into a park, it was thought wise to procure, at some suitable level, water needed for the (park) lakes and for general (park) watering.

"Toward this end the Passy artesian well was dug. . . . The digging was let by contract to a Monsieur Kind, of Saxony, at about 350,000 francs, and was started in 1855. The 'spud-in' casing diameter was (about) 48 inches and the final casing diameter, top to bottom, about 32 inches. (Depth 1800 feet.)

"But an important cave-in of the (deep) clay strata having gravely damaged the casing, necessitating considerable repairs, completion was delayed till September, 1860. (M. Kind was bankrupted by the cave-in, but was retained, on salary, by Belgrand, and completed the well.) At first the well flowed (about) 4,000,000 U. S. gallons per 24 hours, but cave-ins at the base of casing and other troubles reduced the flow to about 1,500,000 gallons, which, however, is sufficient to furnish all needed water for the Bois de Boulogne."

Col. Bechmann also mentions two other artesian wells, undertaken by the City after completion of the great Passy well.

METERS

All services are metered. Meters are well designed and beautifully "finished." The ordinary dwelling-house meter reads to a single litre.

RATES

I have no "tariff sheet" of water rates, but from the memory of studying the water bills, (payable quarterly), of several friends, they are somewhat lower than those of the average American city.

OWNERSHIP (AND OPERATION)

The entire system (except meters, which are the property of the owner of the building) is owned by the municipality, but operated by a private corporation (la Compagnie generale des Eaux) under a rather complicated lease contract.

THE MUNICIPAL WATER SOFTENING PLANT AT GLENDIVE, MONTANA

By C. W. Eyer

(*City Engineer and Water Superintendent, Glendive, Mont.*)

The City of Glendive draws its municipal supply from the Yellowstone River. The raw river water is moderately hard in the Summer and objectionably so during the Winter months, with a yearly average of 14 grains per gallon. The water is usually very turbid, requiring considerable chemical treatment for sedimentation.

The task of promoting the Glendive softening project proved quite difficult, but extremely interesting. It was necessary first to educate the consumer to the fact that the lime added for softening would not come to him through the tap. The layman considers chemistry as more or less a mystery and believes anything termed a "chemical" to be unusually harmful to the human system.

It actually became necessary in some cases at Glendive to treat a small sample of hard water with lime and show the precipitate formed, in order to prove that we were actually taking something undesirable *out* of the water rather than merely adding a new element for no good purpose.

Through this type of education, supported by a studied campaign of publicity in the press and at public gatherings, the Glendive project was finally undertaken under the loan-and-grant provisions of the Public Works Act.

The community authorized an issue of $15,000 in 4 percent bonds, to be supplemented by a grant of approximately $6,100 in Federal funds.

Those of you who have conducted the negotiations necessary to final approval of a PWA project will readily understand the difficult and protracted procedure involved.

As a matter of fact, we finally found it necessary to buy our own bonds in order to expedite construction. Actually, this has proved to be a wise move, as we invested in these 4 percent bonds a surplus in our Depreciation Reserve Fund, using a dead balance returning

but ½ percent interest. To date we have not received any of the 30 percent Federal grant, but by the means above described we have been able to complete the plant in a prompt and satisfactory manner.

The construction contract was awarded October 12, 1934 in a total of $19,235.00. It provided for the remodeling of the mixing and sedimentation sections of the old plant to adapt it for the softening process.

The plant was completed March 11, 1935. It has now been in operation so short a time that we cannot yet determine accurately the final operating results. We have, however, already gained a general estimate of the results and benefits to be realized.

CONSTRUCTION OF PLANT

Our plant uses the lime-soda process of softening, but has one unusual feature in that we obtain the soda-ash supply from a deep well drilled and equipped deliberately for that purpose. So far as we can learn, ours is the only plant using this unique method of procuring one of the essential softening chemicals.

The principal features embodied in the construction of the plant were:

1. Installation of a rate-of-flow controller in the raw-water line.
2. The rebaffling of the mixing chamber to insure a more thorough mixing of the softening chemicals, the raw water, and the well water.
3. Installation of two dry chemical feeders.
4. The building of a new concrete basin with installation of a "flocculator" or paddle-wheel type mixing device.
5. The rearranging of the first settling basin and erection of a syphon feed clarifier and sludge removal pump.
6. Installation of a recarbonating unit with a distribution grid in the basin just after clarification.
7. The drilling of a 100-foot well equipped with a deep-well turbine type pump and rate-of-flow controller.

THE TREATMENT PROCESS

The process consists of feeding hydrated lime and sodium aluminate in correct proportions to the incoming raw river water. Sufficient well water is added to provide the required amount of soda-ash. The baffle mixing chamber accomplishes the mixing in a fairly satisfactory manner. The flocculator builds up the floc so that it readily settles out in the clarifier.

A portion of the clarifier sludge is now being returned to the mixing chamber, and this plan is proving highly advantageous. Before starting this recirculation of sludge a considerable portion of the calcium carbonate remained in suspension in a state so fine that it carried over to the filters and caused complete stoppage in a short time.

With the addition of a large amount of sludge to the mixing chamber, even in highly turbid water, the nearly colloidal precipitate of calcium carbonate is settled out in the clarifier and the filter runs become normal.

We also noted that lime requirements were reduced nearly 10 pounds per hour as a result of sludge recirculation.

After clarification the water is recarbonated, settled and filtered. Chlorine and ammonia are then added for purification.

Our raw water varies in turbidity from 50 to 50,000 p.p.m., and the hardness ranges from 8 to 24 grains per gallon, with approximately one half the hardness in the non-carbonate form, combined with a considerable quantity of magnesium.

Our purpose is to produce a water with 5 to 6 grains of hardness per gallon, with as low an alkalinity as possible and carrying just a trace of hydroxide. The residual hardness is then chiefly calcium sulphate, the least objectionable of the various forms of hardness. The magnesium is all removed, as it is the most objectionable. When combined with soap this magnesium forms the gummy scum which is so unsightly and so difficult to remove from bathroom fixtures.

RESULTS

Since putting the plant in operation, results have been somewhat erratic due to mechanical causes which we are gradually rectifying by careful adjustment of the equipment.

At present the water is being softened from approximately 20 to 5.5 grains per gallon. Due to the large amount of magnesium hydroxide and magnesium aluminate formed in the process our filter runs have been doubled, with half the wash water required for washing as compared with previous clarification practice.

Alum is no longer necessary to aid sedimentation. Before softening, our filters were heavily over-burdened due to lack of adequate sedimentation space. Now, however, the influent water to the filters is practically clear.

By carrying a hydroxide alkalinity in the flocculator and clarifier,

the bacterial load is materially reduced on account of the sterilizing action of the lime. The chlorine now necessary for purification is about two-thirds the amount required previously, with the probability that it may be reduced still more.

Thus far the chemical cost averages about 3 cents per thousand gallons. Or, on a comparative basis, we use about 11 pounds of lime per million gallons of water per part per million of hardness removed. This does not include the cost of recarbonation, which we have not yet accurately determined.

The difference between the cost of alum and aluminate for plain sedimentation, and the cost of lime and aluminate for softening is about double. However, the savings realized from soft water will, of course, offset the additional cost many times over.

The unique feature in operation of our plant is the procuring of the soda-ash from our own well water. This well water carries 7.2 grains per gallon of free sodium carbonate and 35.2 grains per gallon of sodium bicarbonate, which latter is changed to soda-ash by adding lime. The well water also carries a small amount of chlorides, some iron, a trace of hydrogen sulphide, and about 12 grains per gallon of sodium sulphate which is not sufficient to be objectionable.

PUBLIC REACTION

When all is said and done, the worth of any project must be measured in terms of customer and public reaction. Personally, I have never worked out anything of a public nature that has been so universally accepted. When the majority of the public not merely approves but actually becomes enthusiastic, it is highly gratifying to a public servant.

Of course, a few remain who object and are more than willing to criticize, but that is to be expected in any public undertaking. A few complaints have been registered, one claiming stomach trouble and a few complaining of skin eruptions and roughness. In all probability none of these alleged ills were caused by the water.

One lady who had been skeptical of the predicted saving in soap attempted to use the customary amount of soap with the new soft water, with the result that she had soap suds boiling out of the washing machine and piling up on the floor. At first quite a few objected to the flatness of taste, but after a few days could detect no difference.

All in all, the citizens of Glendive are very well satisfied with their new municipal supply of soft water.

(Presented before the Montana Section meeting, April 12, 1935.)

LEWISTON'S WATER SYSTEM

By W. P. Hughes

(City Engineer, Lewiston, Idaho)

The development of the Lewiston water system is not a great deal different from that of any other old western town. The town was incorporated in 1863, but it was in existence a few years before that time as an outfitting point for the mines in the adjacent country. At the City Hall we have the register of the old Luna House, the town's first hotel, and the owner or clerk made marginal notes in regard to the town's activities, and a fairly comprehensive history can be built around his observations. From these notes we gather that several boats plied between Portland and Lewiston and almost every day from 50 to 100 men arrived who later passed on to the mines into the Florence and Pierce mining districts.

During the early years, water supply was apparently of minor importance. The inhabitants were supplied by shallow wells and later by a ditch which supplied water to a mill located a short distance from where the Lewis-Clark Hotel now stands. It was not until 1890 that the first public utility, a water and light company was organized. The water plant was located on the bank of the Clearwater River in the eastern part of the city, on the site of the present water plant. They secured their supply from the river and pumped from a one million gallon capacity reservoir. This system supplied the present down-town section for a number of years at which time the business area occupied only a few blocks, the remaining area was composed entirely of residences and acreage. Those of you who have examined the perspective drawing of Lewiston made in 1898 will have a pretty good idea of the size and character of the town. After a few years of operation of this privately owned water company a few residences were constructed on Normal Hill on the bench immediately south of the present business district. One of the owners in this new residence district constructed a wooden main to supply a few homes in that section.

The city purchased the water system in 1902 and the following year

made extensive improvements installing a motor driven pump to replace the old steam unit, constructed a high service reservoir to supply the Normal Hill area and installed several miles of wooden mains. At this time the supply mains were wood, galvanized and black pipe. In 1907 it became necessary to increase the size of the distribution main in the business district so a 12-inch steel line was laid. From that time the wooden mains were gradually replaced with steel. For several years following the system just grew without any definite plan as residence building on Normal Hill expanded. Mains were laid hither and thither as the demand arose, additional pumping units were installed as the need existed. Taxes were low so when money was needed for replacements, repairs, etc. it was transferred to the water fund, general fund or a bond issue was voted. Apparently no effort was made to study the water rates in view of increasing the revenue or increasing the efficiency of the department to make it self supporting. Haphazard methods were employed in pipe installations and no record was kept of pipe lines or gate valve locations.

All through these years whenever there was a freshet and during the spring run-off the people were served with muddy water. For several miles above Lewiston the Clearwater River is fed by streams which drain farming areas. Several towns are located on the banks so that when the water reaches Lewiston it is highly polluted. The people used this polluted water during the early years accepting muddy water in the freshet period and epidemics of typhoid fever as a matter of course. The "Guess" system of chlorination was started in 1918. Finally tiring of these conditions in 1923 the people voted a water bond issue for extension and replacements. A firm of nationally known consulting engineers were employed for preliminary investigation, design and construction. Out of the bond issue were constructed a modern filtration plant, two new concrete reservoirs with a combined capacity of 7,600,000 gallons, 7 miles of cast iron pipe replacements and the installation of new pumping equipment. The pipe lines laid during this replacement were the first cast iron installations in the system.

In 1925 a short time after the new plant was put in operation the Water, Street and Engineering Departments were combined and placed under one executive. The City Council desiring to protect the investment in the new water plant and to remove the public works and utilities from the influence of politics as much as possible

placed the City Engineer at the head of three departments. This move resulted in increased efficiency as it made possible the employing of fewer, but a higher type personnel resulting in a lower cost of overhead. This plan has worked out very well as all of our employees are familiar with the details of all three departments and are capable of doing any detail of the work that may arise. An additional advantage is that our field crews are familiar with the work of both the water and street departments and may be employed in emergencies that rise in connection with either division.

The water flows by gravity to our pumping plant through two-24-inch cast iron mains from the center of the river channel to the suction well or grit chamber. From here a battery of three low service pumps lift it to the mixing chambers where sulphate of alumina and hydrated lime are added by three chemical dry feed machines. The low service pumps are of different sizes so that the plant can be operated at the rate of 2, 3, 4, 5 or 6 million gallons per day according to the unit or combination of units of raw water pumps employed.

From the mixing chamber the water flows slowly through the sedimentation basins, the retention period being $3\frac{1}{2}$ hours when operating at full capacity. From the sedimentation basins it flows by gravity to the four filters. These filters are of rapid sand type 18 inches of graded gravel supporting 30 inches of sand. Through the filters the water passes to the clear well where liquid chlorine is added at the maximum rate of 2 pounds per million gallons. From the clear well the water is pumped to the four reservoirs about one mile distant and 300 feet in elevation.

The pumping equipment consists of a two stage centrifugal 8-inch pump delivering 2100 gallons per minute to the high reservoir with an emergency or stand by unit a 10-inch pump of 2800 gallons per minute. The low reservoirs are served with a 10-inch pump with a capacity of 1600 gallons per minute with an emergency or stand by unit of the same capacity. The cost for the entire process from the time the water leaves the river until it reaches the reservoir is slightly over 5 cents per 1000 gallons.

Practically the only trouble we have had with the plant during its 11 years of operation was a slight disruption of the filter beds. This occurred three years ago. We rebuilt the four beds at a cost of $1200 using 6 layers or graduations of gravel instead of the four in the original specifications. This change has eliminated all the troubles from that source.

The only other additonal work was the installation of a capacitor which has reduced our power bill $2000 per year.

We have an up to date laboratory and tests of raw and filtered water are made daily. Periodical tests of water are made from various parts of town.

We have 40 miles of mains from 2- to 16-inches controlled by 800 gate valves. Since 1924 all our replacements and extensions have been of cast iron of larger size and now 46 percent of our lines are of this material. All of our new services are copper.

We have 4 reservoirs, two on low service and two high service. The low service consists of a 1,000,000 gallon brick structure, the oldest in the system, and a 4,000,000 gallon concrete structure. The high service are a 1,000,000 gallon brick and a 3,600,000 gallon concrete.

We have a well equipped shop for our line crews including a complete meter testing outfit.

(Presented before the Pacific Northwest Section, May 17, 1935.)

THE DETERMINATION OF SODIUM CHLORIDE IN SALT

By C. W. Foulk and John R. Caldwell

(*Department of Chemistry, The Ohio State University, Columbus, O.*)

The usual method of analyzing an approximately pure substance, such as salt for the regeneration of zeolite, is to determine the impurities and subtract their sum from the total. There is, however, another way that deserves more attention than it receives in spite of its limited application, namely, the precipitation of the greater portion of the pure substance and then the determination of the smaller portion by a method adapted to small amounts. The success of this plan depends on finding conditions of precipitation that will result in a very pure precipitate, in other words, completeness of precipitation is sacrificed in the interests of purity of precipitate. The analysis of salt (sodium chloride) as given below is a case in point. It consists in the precipitation of about 94 percent of the sample as sodium chloride by means of concentrated hydrochloric acid and the remaining portion, after expelling the excess of acid, as sodium magnesium uranyl acetate.

Richards and Wells (2) have shown that the precipitated sodium chloride is very pure, and Caley and Foulk (1) have demonstrated the applicability of the magnesium uranyl acetate method to small amounts of sodium.

PRECIPITATION OF SODIUM CHLORIDE

One gram of sample is dissolved in 5 ml. water. If an aliquot part of a solution is used it should be evaporated to 5 ml. Ten milliliters of concentrated hydrochloric acid, sp. gr. 1.19, is then added slowly with agitation to cause the formation of large salt crystals, and the mixture evaporated to 4 or 5 ml. cooled, and 5 ml. of concentrated hydrochloric acid added, after which the precipitated salt is filtered in a crucible with a porous bottom. Jena glass crucibles with sintered glass bottoms were used. The salt is transferred to the crucible with the minimum amount of concentrated acid. A rubber tipped rod may be used. Filtrate and washings, about 30 ml. in all, are

received in a test tube in the filter flask. After the removal of the crucible, its support should be rinsed with a fine stream of water and the rinsings added to the test tube. The crucible containing the salt is heated very slowly at first and finally to dull redness for 30 minutes. It is then cooled and weighed. In order to prevent possible loss by decrepitation it is best to keep the crucible tightly covered during the first period of heating. The weight of salt obtained in this precipitation with acid will be approximately 94 percent of the total.

PRECIPITATION OF SODIUM AS TRIPLE ACETATE

The preparation of the reagents and method of precipitation are described in several places (1, 3), but for convenience they are repeated here.

Magnesium uranyl acetate reagent (3)

Solution A		*Solution B*	
Uranyl acetate ($2H_2O$)...	90 g.	Magnesium acetate ($4H_2O$).............	600 g.
Glacial acetic acid.......	60 g.	Glacial acetic acid.....	60 g.
Water to...............	100 cc.	Water to...............	1000 cc.

Each solution is heated to about 70°C. till everything is dissolved, and then the two solutions are mixed at this temperature and allowed to cool to 20°. The vessel containing the mixture is then placed in water at 20° and held at that temperature for one to two hours till any excess of salts has crystallized out. The reagent is next filtered through a dry filter into a dry bottle. It keeps perfectly.

PROCEDURE FOR PRECIPITATION

About 0.5 g. ammonium chloride is added to the filtrate and washings from the precipitated sodium chloride above, to prevent the separation of any calcium sulfate, and the solution evaporated to dryness. The residue is then dissolved in 5 ml. water and 200 ml. of the magnesium uranyl acetate solution added. The flask containing the mixture is at once immersed in water at 20°C. and the solution vigorously agitated for 30 to 40 minutes, during which time the temperature should not be allowed to vary more than 0.5° from 20°. The yellow crystalline precipitate is then filtered into a weighed filtering crucible and washed with successive 5 ml. portions of 95 percent alcohol, after which crucible and contents are dried at 105 to 110°C. for 30 minutes and weighed. The weight of the precipitate

in grams plus 1 mg. for each 5 ml. portion of alcohol used in washing, times the factor 0.0389 gives the amount of sodium chloride.

NOTES

1. The agitation of the solution during precipitation must be vigorous and continuous in order to effect complete precipitation and to prevent the precipitate from adhering to the sides of the flask.

TABLE 1

Tabular statement of test analyses

NUMBER	NaCl TAKEN	ADDED SALTS	PRECIPITATED NaCl BY HCl	PRECIPITATED NaCl IN FILTRATE	TOTAL NaCl RECOVERED	TOTAL ERROR	ERROR UNACCOUNTED FOR
	gr.	*gr.*	*gr.*	*gr.*	*gr.*	*percent*	*percent*
1	1.0009	0.03 $CaSO_4$ 0.05 $MgCl_2$	0.9204	0.0796	1.0000	−0.09	−0.04
2	1.0001	0.05 $CaSO_4$ 0.03 $MgCl_2$	0.9473	0.0522	0.9995	−0.06	−0.01
3	1.0000	0.05 $CaSO_4$ 0.05 $MgCl_2$	0.9545	0.0467	1.0012	+0.12*	
4	0.9998	0.05 $CaSO_4$ 0.05 $MgCl_2$	0.9405	0.0587	0.9992	−0.06	−0.01
5	1.0000	0.05 $CaSO_4$ 0.02 $FeCl_3$	0.9496	0.0497	0.9993	−0.07	−0.02
6	1.0000	0.05 $CaSO_4$ 0.02 $FeCl_3$	0.9387	0.0604	0.9991	−0.09	−0.04
7	1.0000	0.05 $CaSO_4$ 0.04 KCl	0.9360	0.0633	0.9993	−0.07	−0.02
8	1.0000	0.05 $CaSO_4$ 0.04 KCl	0.9451	0.0541	0.9992	−0.08	−0.03

* This sample was evaporated to 2 ml. instead of 4–5 ml. The precipitated sodium chloride gave a strong test for sulfate, showing that $CaSO_4$ or $MgSO_4$ was carried down.

2. The washing correction can be avoided by using 95 percent alcohol saturated with the precipitate.

3. Other details can be found in the papers under reference (1).

4. It is obvious that the volumetric method of Furman, Caley and Schoonover (4) could also be employed for measuring the amount of the sodium magnesium uranyl acetate precipitate.

TEST ANALYSES

To test the accuracy of the method, it was tried on several synthetic mixtures that simulated specimens of commercial sodium

chloride. The impurities, however, were added in larger quantities than are ordinarily found in salt. The sodium chloride was prepared by twice precipitating a C. P. grade from solution with concentrated hydrochloric acid, and may therefore be considered pure. Results of the test analyses are shown in table 1.

In order to test the purity of the sodium chloride precipitated by the hydrochloric acid, the salt was removed from the crucible in each case and dissolved in water. The solutions thus obtained were tested with the appropriate reagents for contaminating ions. Samples 1 and 2 gave a perceptible turbidity with barium chloride. When examined with a turbidimeter, the quantity of sulfate was found to be below 0.05 mg. calcium sulfate, or out of the range of ordinary analytical methods. Sample 4 gave a barely perceptible test for calcium with ammonium oxalate, and the clear filtrate from this precipitate showed a trace of magnesium when treated with ammonium phosphate. Sample 6 showed a slight color when tested for iron, with potassium ferrocyanide. Samples 7 and 8 were treated with sodium cobaltinitrite and allowed to stand for several hours. At the end of this time, a very light film of potassium-sodium cobaltinitrite had settled out, just enough to be perceptible and corresponding to a quantity of potassium chloride well below 0.05 mg. Sample 3 shows the effects of too much evaporation and points to the fact that the volume must be kept between 4 and 5 ml. to obtain a good separation.

DISCUSSION

In table 1 the percentage error was calculated by the equation,

$$\text{Percentage error} = \frac{\text{Deviation from true value}}{\text{True value}} \times 100$$

In the column marked "total error," the actual error of the procedure is given. However, this can be accounted for almost entirely by the magnesium uranyl acetate precipitation. As shown by Caley and Foulk (1), the method has a negative error of about 0.2 mg. for quantities of sodium in the region of 20 to 50 mg. This corresponds to 0.5 mg. sodium chloride, and when subtracted from the total error, it is seen that the quantity of sodium chloride unaccounted for, as recorded in the last column, becomes vanishingly small, and it is evident that sodium may be determined in this way with a greater certainty than by the usual difference method.

The practical application of the method in water technology is in the examination of salt for use in the regeneration of zeolite softeners.

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INTERFERENCE OF ALGAE WITH TESTS FOR RESIDUAL CHLORINE

By E. W. Johnston and W. R. Edmonds

(Assistant Sanitary Engineers, Department of Health, Ontario, Canada)

Modern practice in the chlorination of water utilizes chemical tests for the adjustment of dosages, the most common procedure being that which involves the ortho tolidin test. The starch iodide test has also had a wide application in this work, but has largely been superseded now by the former method. The ortho tolidin test is a color reaction, and it indicates the presence of residual or free chlorine after a definite period of contact between the chlorine and the water. This method is subject to certain defects, the main ones reported being due to the presence of iron, manganese and nitrites. No instances apparently have been recorded previously where algae in water treatment plants have caused interference in the reactions with either of these chemical tests.

The ontario Department of Health, when conducting some tests in the summer of 1934 at the water filtration plant at Belleville, Ontario, was faced with an unusual condition in the raw water. When ortho tolidin was added a distinct color was immediately produced, equivalent to that obtained with a residual chlorine content of about 0.3 p.p.m. When this same water passed through the filters, and the ortho tolidin was added no color resulted. While this phenomenon has no significance as far as this plant is concerned, since the chlorine is applied after filtration, it may have a very disconcerting effect on supplies which are chlorinated only and where this test or the starch iodide test is utilized for adjusting the dosage of chlorine.

ACTION OF ORTHO TOLIDIN WITH CHLORINE

The color produced by the action of free chlorine on ortho tolidin is due to the oxidation of the latter. Other oxidizing re-agents shown to produce color reactions with the ortho tolidin solution are as follows:

Ozone, nascent oxygen, sodium nitrite, ammonium persulphate, ferric chloride, ferric alum, potassium permanganate, potassium

bichromate, sodium peroxide, lead peroxide, hydrogen peroxide, bromine, iodine, and nitric acid.

THE BELLEVILLE PLANT

The water treatment plant at Belleville is a modern design of the gravity mechanical type and consists of 4 filter units with a total designed capacity of 4 m.g.d. The population supplied is 14,500 and the average daily consumption is 1,800,000 Imperial gallons. The source of supply is the Bay of Quinte on Lake Ontario. The raw water differs a good deal from that of the Great Lakes, and is influenced by the colored water of the Trent River which empties into the bay about 10 miles west, or upstream, and at certain times by the Moira River located about ½ mile downstream. The raw water, from the intake, enters the low lift pumpwell which also forms the screen chamber. The alum is applied in front of the screens by dry-feed equipment. From the screen chamber the water is pumped by low lift pumps to spiral flow mixing tanks and coagulation basins consisting of three separate units, which provide in all a retention period of 3 hours. The settled water passes to the influent line of the filters. The rate of flow through the filters is hydraulically controlled. After filtration the water passes into a clear water reservoir of 250,000 gallons capacity. High lift electrically driven pumping units and gasoline operated pumps for emergency, deliver the water from the well to the distribution system and stand pipe. The filtered water is chlorinated in the channel leading from the clear well to the high lift pump suctions. An elevated tank over the coagulation basins provides wash water for the filters.

A chemical examination of a sample of the raw water secured at Belleville on August 15, 1934, showed the following results in parts per million, unless otherwise noted:

Nitrite	0.0	Oxygen consumed	4.4
Nitrate	0.0	Chlorine as chlorides	3.5
Fe	0.2	Total hardness	84.0
pH value of raw water	8.4	Manganese	0.0
pH value of tap water	7.2	Colour	Yellowish brown

Shortened filter runs

The average filter runs had been such that washing was required only 3 times a week, that is runs of 60 hours were readily attained under normal conditions. Beginning about July 12, 1934, the loss

of head increased so rapidly, with "breaking" or "cracking" of the sand beds, that the filter runs were reduced to approximately 3 hours. These shortened runs in July, during a very dry season, placed such a demand upon the plant as to occasion considerable concern for the officials in charge. The filters had to be operated at full capacity to meet the demand. This condition coincided with the appearance in the raw water of a high concentration of algae, identified for the most part as Clathrocystis, one of the Cyanophyceae group or blue green algae. In 1933 also the filter runs were reduced beginning with the "algae period" in late September. The Clathrocystis was not removed in the coagulation process, but was carried through the mixing and settling basins to the filters. This material may be aptly termed "green paint" as the sides of the filters soon became coated with a pea green colored slime.

Microscopic examination

During this "algae period" the raw water showed a definite reaction with the ortho tolidin solution. At other times no change was noticeable. Since the material or substance in the raw water causing this color reaction was apparently removed in the process of filtration, laboratory tests were made to confirm this action. Raw water was passed through analytical filter paper. The filtrate gave no color reaction with ortho tolidin indicating that suspended rather than dissolved matter was responsible. A sample of the precipitate was washed with distilled water, and then placed in a tube containing distilled water. With the addition of ortho tolidin a strong color reaction took place.

The suspended matter from a sample was concentrated by passing about 200 cc. of water through a disc of bolting cloth supported in a Sedgwick-Rafter type funnel filter. A microscopic examination of the retained particles revealed the bulk of the material to consist of blue green algae with a lesser amount of green algae and some diatoms. Those identified are as follows:

Class	*Genus*	*Non-technical description*
Cyanophyceae	Microcystis Clathrocystis	Blue green algae
	Anabaena	
Diatomaceae	Stauroneis	Diatom
Chlorophyceae	Spirogyra Zygema	Green algae

Other laboratory tests

Other laboratory experiments were carried out using different kinds of algae, as well as samples of the Belleville supply which had been kept in an amber bottle with no special care, and likewise samples preserved with formaldehyde. The results indicate that some algae do interfere with the ortho tolidin, and also the starch iodide tests used for detection of residual chlorine. Experiments were made jointly by the Provincial Department of Health and the Ontario Fisheries Research Laboratories of the University of Toronto.

Most of the laboratory tests were made during the winter season when it was difficult to obtain the various kinds of algae. Therefore only an interim report of the findings is being presented at this time. Further experimental work in a study of this phenomenon during the algal season may provide additional data at a later date.

Some of the tests made in this investigation are as follows:

About 200 cc. of a sample of the Belleville water held for about two months without special care, was centrifuged at a speed of 20,000 r.p.m. The centrifuged material gave a positive reaction when suspended in 10 cc. of distilled water and ortho tolidin added. The water which went through the centrifuge was negative in reaction.

A sample was passed through plankton silk. Again a strongly positive reaction was obtained with material removed by the silk. The causative agent, however, was not completely removed by the silk as a slight but positive test was obtained with the water which passed through it.

Boiling this water did not destroy the substance causing the positive reaction with ortho tolidin. The substance, however, was destroyed when a sample was boiled with hydrochloric acid. Merely washing the suspended matter, retained on a filter paper, with warm dilute hydrochloric acid seemed to have little effect, and did not destroy the coloring substance.

Several leaves of Elodea were crushed and the ortho tolidin added. The positive test was very faint.

A number of plants of duck weed were tested producing a deep yellow color. Some species of duck weed were again examined later and gave negative reactions.

A few miscellaneous samples were examined. A piece of dead moss, taken from the bottom of an aquarium, gave a strongly positive reaction. A green leaf of a tree of undetermined species gave a

slight but positive reaction, but no change occurred when a dry leaf was tested.

Tests as to the cause of the reaction

Further investigations have been conducted to ascertain if the resulting color in the previous experiments was the result of a straight solution change brought about by the addition of acid or whether it was an oxidation of the ortho tolidin. The samples of algae in the following experiments were examined, with the ortho tolidin test, hydrochloric acid, and the starch iodide test.

A green algal suspension, composed chiefly of Scenedesmus, was tested with ortho tolidin and gave a strong positive reaction producing a deep yellow color. The procedure was repeated using 10 percent hydrochloric acid instead of ortho tolidin. The reaction was negative. The starch iodide test was then performed. The solution turned a light blue indicating a similar reaction by the algae.

A species of green algae, Mougeotia, was examined. This sample was taken from a fish aquarium exposed to a 40-watt electric light bulb. Upon the addition of ortho tolidin a deep yellow color occurred. It gave a negative reaction to hydrochloric acid. The green coloring matter from the plant, dissolved in distilled water, gave a positive reaction to the starch iodide test. This reaction, however, was not positive in every instance.

A filamentous alga identified as Cladophora, gave a very strong positive reaction to ortho tolidin. This alga grows as a felt-like mass and was taken from an aquarium in the Ontario Fisheries Research Laboratory. When ortho tolidin was poured upon a small portion of this plant, the ortho tolidin rapidly changed to a deep yellow and the color was dispersed throughout the entire specimen. There was no color reaction to hydrochloric acid.

The water in contact with this alga showed a slight trace of nitrites. The alga was removed, washed, placed in tap water, and left overnight. Next morning it gave a positive reaction, but not as uniformly strong as that which occurred the previous day. No nitrite was present in this water. The alga was then left exposed to the sunlight and when the sample was tested later in the day a strong, positive reaction with ortho tolidin was readily obtained on all tests. There was a slight trace of nitrites present. The alga was then carefully washed until no trace of nitrites was found. It still gave a strong positive reaction with ortho tolidin.

Further work on this species of alga revealed the fact that if washed with cold water or placed in cold water the speed of the action of the ortho tolidin upon it was greatly delayed. On the other hand, if the alga were placed in hot water to which ortho tolidin was added a strong positive reaction took place rapidly.

A leaf of the water plant known as Vallisneria was examined. The leaf of this plant was covered with a slimy green algal growth composed of Oscillaria. It gave a strong positive reaction with ortho tolidin. The Oscillaria was then scraped off and the leaf thoroughly washed after which ortho tolidin was poured directly upon the leaf. A slight positive reaction occurred. The Oscillaria also gave a slightly stronger reaction than the leaf of the Vallisneria.

Water containing some Cladophora was tested as follows:

1. Chlorine was added to a sample and upon the addition of ortho tolidin a color reaction took place.

2. A second sample was chlorinated and sodium thiosulphate was added to neutralize the chlorine. Half of the algae was removed, thoroughly washed and placed in water and allowed to stand in the sunlight for about 4 hours. Ortho tolidin was added to each sample. There was no reaction in the first but a color reaction took place in the washed sample.

3. A third sample was treated with sodium thiosulphate alone. Half of the algae was removed, thoroughly washed and placed in tap water and allowed to stand in the sunlight for 4 hours. Ortho tolidin was added to each sample. No reaction occurred in the first but there was a reaction in the washed sample.

ENZYMES AND THEIR ACTION

Since this phenomenon may be associated with the action of enzymes it might be well to briefly describe some of their characteristics and properties.

An enzyme is an organic catalyst elaborated by a vegetable or animal cell and whose activity is entirely independent of any of the life processes of such a cell.

There are various classes of enzymes such as proteolytic, deamidizing, oxidizing, reducing, etc. The class name indicates the individual type of enzymatic activity which that class is capable of accomplishing.

Enzymes are very difficult to prepare in anything like a condition approximating purity, since their nature often changes during the

process of isolation. Their presence may be proven from the nature of the end products of their reaction, and not through the agency of any chemical tests. They are colloidal and non-diffusible.

Many of the important enzymes do not occur preformed within the cell, but are present in the form of a zymogen or mother substance. In order to yield the active enzyme this zymogen must be transformed in a certain specific manner and by a certain specific substance.

Enzymes are very specific as to the character of the substrate or substance acted upon. The enzyme and its substrate must have an inter-relation, such as the key has to the lock or the reaction does not occur.

Classification of enzymes

NAME OF AND CLASS	DISTRIBUTION	SUBSTRATE	END-PRODUCTS
Oxidases:			
1. Catalase......	Plant and animal tissues	Hydrogen peroxide	Oxygen or oxidation products
2. Laccase.......	Lac tree, fungi, etc.	Polyhydric paraphenols as hydroquinol and pyrogallol	Oxidation products
3. Peroxidase....	Plant and animal tissues	Organic peroxides	Oxygen or oxidation products

PROTEINS AND AMINO ACIDS

The proteins are a class of substances which consist mainly of combinations of alpha amino acids and their derivatives.

Proteins are essential constituents of all living cells and therefore without them vegetable life as well as animal life is impossible. They contain in addition to carbon, hydrogen and oxygen, invariably nitrogen and generally sulphur also. Some contain phosphorous, iron, copper, iodine, manganese and zinc.

The decomposition of protein substances may be brought about by oxidation or hydrolysis. The decomposition products include proteoses, peptones, peptides, carbon dioxide, ammonia, hydrogen sulphide, and amino acids. These amino acids constitute a long list of important substances and are pre-eminently the most important class of protein decomposition products. They are able to form salts with both bases and acids.

The present phenomenon may be the result of an enzymatic acitivity, owing to the presence of an oxidizing enzyme contained within the plant tissue or it may be the result of the presence of an amino acid which reacts to give a similar result to that obtained by the presence of nitrites.

CONCLUSIONS

From the observations made in these preliminary investigations it would appear quite definite that under certain conditions the presence of algae may cause a very distinct interference with the ortho tolidin and starch iodide tests for the presence of free chlorine in water. The definite reason for this condition cannot at this time be accurately reported, and further work is to be carried out. Two possible factors, which may be the same factor, however, appear to be involved.

1. A straight reaction between the coloring matter in algae, and the chemicals used in these tests.

2. An oxidation of the testing solution brought about by the presence of atomic oxygen. The fact that both ortho tolidin and starch iodide react similarly strengthens this contention. The removal of the oxygen from the plant by sodium thio-sulphate also causes a negative reaction, but this returns when the plant is allowed to stand in sunlight.

It is desired to express thanks to the Ontario Fisheries Research Laboratory at the University of Toronto under Professor W. K. Harkness for assistance in the study of this problem.

(Presented before the Canadian Section meeting, March 29, 1935.)

REFERENCE

Hawk, P. B.: Practical Physiological Chemistry.

PROBLEMS IN WATER FILTRATION PLANT OPERATION

BRANTFORD, ONTARIO

By F. P. Adams

(Manager and City Engineer)

The functions of a water filtration plant for a public water supply are to furnish a water bacterially safe for consumption and a water that is potable.

A few years ago the first condition was all important, but with the widespread use of chlorine as a germicide in the water, the filters have been relieved of this function to a great extent.

It is with the second function of a filtration plant that we wish to deal in this paper.

A potable water must be: free from turbidity; colorless; free from taste or odor; and of reasonably low temperature.

The Grand River from which the City of Brantford obtains its water supply is subject to extreme variations of flow and during periods of high water the turbidity becomes very great. Under flood water conditions large quantities of water are released from extensive swamp areas at its source which are highly colored. Thus under flood conditions the river water has both high turbidities and color. Approximately turbidity and color increase proportionately to a rise in water levels, but during a fall in levels the turbidity diminishes more rapidly than the color.

During the summer months the flow in the river becomes very low. The difference between spring flood and dry weather flows is from a maximum of 36000 to a minimum of 55 c.f.s. This low summer flow brings with it an objectionable odor and taste condition combined with high water temperatures.

These extreme conditions impose on the filters loads which would be very difficult to handle and would necessitate a heavy charge for chemicals in order to give an approximately potable water under all the varying conditions of the raw river water.

Fortunately the water department has an area of farm lands

adjacent to the water works plant that is underlaid with from 10 to 15 feet of coarse gravel from which the City formerly obtained its water supply by infiltration from the river. This is now used to give a preliminary treatment to the water. The sod is cleared from an area of about an acre and the raw water is pumped on to this area. Collecting tiles are located about 8 feet below the surface which carry the partially filtered water to the suction well of the low lift pumps. The water is then coagulated, filtered, and chlorinated through a modern rapid sand gravity plant.

No turbidity and very little color remains in the water after passing through the ground. What does remain is taken care of by the filters.

Odor and taste are corrected by the use of activated carbon when necessary. The carbon is applied to the water at the same time as [illegible] plant, i.e., before the water enters the mixing chamber. It was found necessary to introduce Nuchar to the water on 19 days during 1934 and then at the rate of about 10 pounds per million gallons. This has no effect on removing color, but it does remove objectionable tastes and odors.

The use of alum for coagulating the water has been greatly reduced by the preliminary ground treatment, the average dose during 1934 being 0.47 grain per gallon.

The average dose of chlorine for the year 1934 was 4.36 pounds per million gallons; one-half the amount being applied before filtration and the balance after filtration. The free chlorine in the filtered water was maintained at 0.1 p.p.m.

The temperature of the water is something that we cannot control. During the summer it runs as high as 72°F. If some inexpensive method of lowering the temperature to say 60°F. could be devised it would add greatly to the potability of the water.

One thing very important in maintaining the quality of a filtered water is to make sure that there is no absorption of taste or odor from sediment in the coagulating basin. During warm weather this sediment soon begins to putrefy, and fresh water passing over it picks up odors and taste. We make a practice of cleaning out the coagulation basins monthly during the warm summer months and every two months during the winter. The activated carbon helps to sweeten the silt in the basins when it is used regularly, but frequent cleaning gives surer results.

The cost of chemicals for treating this water including alum,

Nuchar and chlorine amounted to $1.68 per million gallons. Without the assistance of ground filtration the figure might easily have been five times this amount.

HAMILTON, ONTARIO

By D. H. Matheson

(*Chemist and Bacteriologist*)

In relatively clear waters, such as that with which we have to deal at Hamilton, the effect of plankton is a matter of extreme importance in the operation of a water purification plant. During the past year two problems have arisen, both attributable to the large quantity of miscroscopic organisms.

Clear water is essential to the maximum growth of plankton. From April 8 to September 6, 1934, a period of 152 days, the turbidity of our supply did not appreciably exceed 5 p.p.m. During the same period, the plankton increased to a maximum of 1100 mg. of dry weight per one thousand litres of water, equivalent to 6 cubic feet of concentrated sludge per million gallons. During the same period the filter runs decreased from 48 hours or more to a minimum of 3 hours. Somewhat later a period of very offensive tastes occurred, causing considerable complaint.

The relationship between the filter runs and the plankton content of the water is difficult to determine due to the many other interfering factors. However, in considering together cases where the other variables, temperature, turbidity, and applied chemicals were the same, it was found that filter runs and plankton could be correlated satisfactorily. The runs decreased linearly with increasing plankton from 100 to 300 mg. per 1000 litres. Above this value the runs decreased more slowly, and above 400 mg. per 1000 litres they were very short and independent of the plankton.

Up to the period when filter runs began to decrease seriously, the application of alum had been at the rate of 0.5 g.p.g. for two three-hour periods daily. This allowed a certain amount of floc to accumulate on the filters and gave a filter effluent of turbidity less than 0.2 p.p.m. At the first of the short run period the complete omission of alum gave some relief, but the general decline in runs continued. Without the application of alum, the turbidity of the filter effluent was about 0.5 p.p.m. Application of heavy doses of alum

was tried, but did not produce any significant improvement. The plankton cells are naturally sufficiently buoyant to prevent them sinking, and so do not facilitate the sedimentation of the floc. The application of copper sulfate with the alum was tried, but without appreciable effect.

Microscopic examination of the floc showed a large portion (but not all) of the plankton cells entangled in the floc. If the floc could be made heavier in order to settle more readily some improvement might be obtained. This weighting might be done by the addition of artificial turbidity. As iron floc is heavier than alum and settles more readily the use of ferrous sulfate and lime was tried. Due to a mechanical difficulty the application was only made for 12 hours, and before it could be resumed the character of the raw water had so improved that opportunity for a further trial did not occur.

Offensive taste and odor occurred later in the year when the plankton was past its maximum. The untreated water had a fresh algae odor, distinctly noticeable but not offensive in character. After treatment with ammonia and chlorine and passage through the sedimentation basin, the odor was many times stronger, a very offensive odor of decomposition. The same odor could be produced by allowing a concentrate of the plankton to stand for a few days without the addition of antiseptics.

The sedimentation basins which are usually washed out monthly were during this period washed every two weeks. In addition, only one basin was used at a time in order to hurry the water through, to prevent sedimentation of the organisms where they could decompose and to minimize the development of odor in the water while in the basin. The condition persisted off and on for a period of about 6 weeks and then disappeared spontaneously. Activated carbon was tried, but not for a long enough period to secure conclusive data.

PETERBOROUGH, ONTARIO

By William G. Hunt

(Chief Operator)

At the Peterborough Filtration Plant during the past few winters a condition has arisen which has caused some anxiety. After the first year of operation it was found that, as the raw water color during the winter months averaged only about 18, the use of alum

could be discontinued and an effluent of 13 or 14 secured with filtration alone. It has been found that there are no complaints when a water of this color is delivered to the consumers.

In January 1932, however, the color of the raw water increased to 26, in February to 28, in March to 40, and at the same time the pH dropped to 7.1. In order to produce an effluent of reasonable color it was necessary to use alum up to 1.5 grains per gallon which resulted in a pH value of about 6.8 in the filtered water. During this time some complaints were received of red water, but they were few. The spring freshet came on earlier than usual, and although the color further increased, the pH also increased so that the active dose of alum did not result in too low a pH value in the filtered water.

The same trouble developed in 1933, starting about the middle of March. We had been using alum all winter as the color was high, about 43. The pH value varied from about 7.5 to 7.4, but about March 24 the pH value of the raw water dropped so much that we began to get an effluent below 7.0 and the complaints of red water came in in increasing numbers.

We decided to use soda ash and found that one grain per gallon added to the filtered water would bring the pH value back above neutral. We continued this practice until the middle of April when a rise in the pH value of the raw water to 7.8 enabled us to discontinue the use of the soda ash.

We did not experience a recurrence of this trouble in 1934, nor in 1935, and we were able to use alum all winter without difficulty, although the color was high. Due to the higher pH value we were able to use as much as 1.7 grains per gallon without adverse results.

In feeding the soda ash we use a duplicate solution tank and orifice box ordinarily used for the alum feed. The soda ash solution was fed through a rubber hose line to a point where the effluent from the plant poured over a dam on the way to the filtered water reservoir. The point of application was very good, as on account of the turbulence at this location, there was an excellent mixing effect.

If this trouble were regularly experienced we would probably install a dry feeding device of some kind, but as it is apparently intermittent we have not felt that the expense was justified.

We have not decided as yet just what is the cause of the drop in the pH value at these times, but we have certain hypotheses which we think may be the answer.

The rock adjacent to Peterborough is all of the limestone type and this extends north about ten miles. Above this is granite. During the summer months the water from the numerous creeks and small streams discharging into the Otonabee River flows over the limestone rocks becoming very hard as a result of dissolving some of the limestone. This hard water, when mixed with the river water, raises the pH value of the raw water at our intake up to a point where we can use sufficient alum to reduce the color of the filtered water to any degree desired.

In the winter these creeks are either frozen to the bottom, hence there is no discharge, or, if they are flowing, there is a protecting coating of ice on the stoney bottom which prevents the dissolving action. Consequently the water is soft and the pH low. If at the same time the color rises as the result of a thaw, and an increased discharge from the swamps occurs, we then have the condition of high color and low pH in the raw water. In a normal winter when everything stays frozen these creeks do not discharge, the color remains at a low figure and we do not need to use alum. Consequently, while the pH value may be low, it is always high enough to prevent red water troubles.

B. COLI TEST

At the laboratory maintained at the plant, bacteriological tests are made daily on the water. In the past we experienced considerable trouble with what are called spurious fermenters when testing for B. Coli. That is, lactose broth tubes in which heavy fermentation occurred chiefly after 48 hours incubation, frequently failed to confirm on a solid agar medium. It should be pointed out that these 48 hour tests were always negative in 24 hours. We tried the use of brilliant green bile broth for confirming the positive tubes and always got negative results, thus confirming the plate tests. We found also that nearly all positive tubes with brilliant green bile broth, when that medium was used for direct testing, were confirmed both on plates and also lactose broth. As a result of our observations, we decided to use lactose broth for the presumptive test and employ brilliant green bile broth for the confirmation test instead of bile salt agar or Endo's media.

Positive lactose broth tubes which produce typical colonies on the confirmatory plate usually ferment brilliant green bile broth, but we have found that 48 hour fermentors which failed to produce

positive plates also failed to ferment brilliant green bile broth. Consequently we feel satisfied that we are getting reliable and accurate results by this technique without departing from the direct use of lactose broth and at the same time have greatly reduced the routine work by eliminating the use of the solid plates in the confirmation work.

(Presented before the Canadian Section meeting, March 29, 1935.)

COMPARATIVE STUDIES OF MEDIA FOR THE DETERMINATION OF THE COLI-AEROGENES GROUP IN WATER ANALYSIS

By C. C. Ruchhoft

(*Bacteriologist, Sanitary District, Chicago, Ill.*)

A study of various selective media was undertaken by the Standard Methods Committee early in 1934. Fifteen laboratories widely distributed over the United States and Canada co-operated in this study. The media studied included: standard lactose broth, buffered lactose broth, brilliant green bile broth, crystal violet broth, fuchsin lactose broth, formate ricinoleate broth, and methylene blue-brom cresol purple broth. The approval of the proponent of each medium was obtained on all of the media used. The media was prepared and furnished to each co-operator through the courtesy of the Difco Laboratories. The composition of the media used in the tests is shown in table 1.

The method used for determining the comparative coli-aerogenes productivity of the media is that described by Butterfield (1) and Hoskins (2). Detailed instructions were furnished to all co-operators to insure uniformity. Each co-operating laboratory made comparative tests on all media with three freshly isolated coli-aerogenes strains. A total of 73 coli-aerogenes strains were used. The majority of these were isolated from water samples, while several were isolated from feces and one from soil. Laboratory "stock" cultures were not used in these tests. All strains used were sent to the referee for differentiation. For the tests a standardized suspension of the test organism was prepared and 15 tubes of each of three decimal dilutions were planted for each medium. The attempt was made to select the decimal dilutions, so that the intermediate dilution of the standard lactose broth would produce about one-half negative and one-half positive results. One test on a medium comprised the results from a total of 45 inoculations into it, compared with the results of 45 similar inoculations into standard lactose broth. All incubations were made at 37°C. for 48 hours. As only

TABLE 1

Media

MEDIUM	COMPARISON MATERIALS IN GRAMS PER LITER	AMOUNT OF DEHYDRATED MEDIA PER LITER AND MEDIA PER TUBE	STERILIZATION
Lactose broth (Standard Methods)	Beef extract 3.0; peptone 5.0; lactose 5.0	13.0 grams per liter. 10 ml. per tube	15 lbs. for 15 min.
Fuchsine lactose broth	Beef extract 3.0; peptone 5.0; lactose 5.0; basic fuchsine .015	13.0 grams 10 ml. per tube	15 lbs. for 20 min.
Buffered lactose broth	Beef extract 3.0; peptone 5.0; lactose 5.0; dipotassium; phosphate 2.0	15 grams 10 ml. per tube	15 lbs. for 15 min.
M.B. = B.C.P. (Lauter and Dominick)	Beef extract 3.0; peptone 7.8; lactose 4.7; dipotassium phosphate 1.7; potassium dehydrogen phosphate 0.3; erythrosen (L-D) 0.0064; methylene blue (L-D) 0.064; brom cresol purple 0.01	For 1/10 ml. sample portions 18.4 grams per liter. 15 ml. per tube For 1 ml. sample portions 19.55 grams per liter. 15 ml. per liter	15 lbs. for 20 min.
Brilliant green bile	Oxgall 20.0; peptone 10.0; lactose 10.0; brilliant green 0.0133	40 grams. 10 ml. per tube	15 lbs. for 15 min.
Crystal violet lactose broth (Salle)	Peptone 5.0; dipotassium phosphate 5.0; potassium dehydrogen phosphate 1.0; lactose 5.0; crystal violet 0.00143	16 grams. 10 ml. per tube	15 lbs. for 15 min.
Formate ricinoleate (Stark and England)	Peptone 5.0; lactose 5.0; sodium formate 5.0; sodium ricinoleate 1.0	16 grams. 10 ml. per tube	11 to 13 lbs. for 15 min.

coli-aerogenes strains were employed, any gas formation in 48 hours was sufficient for a positive test and confirmations were unnecessary. The procedure using 15 tubes at each of three decimal dilutions in the trial medium and standard lactose broth with inoculations adjusted to produce one-half negative results in the intermediate dilution in the standard was advantageous because it enabled a fairly accurate most probable number estimation. Such an estimation of coli-aerogenes densities is absolutely necessary in a comparative media study.

TABLE 2

Comparison of productivities of trial media with standard lactose broth on the coli-aerogenes group

TRIAL MEDIA COMPARED TO STANDARD LACTOSE BROTH	PERCENTAGE PRODUCTIVITY		
	Based on M.P.N.'s of aggregate data (from 1st report) (1)	Based on mean M.P.N.'s (2)	Based on mean of individual test percentage productivities (3)
Buffered lactose broth	86.0	77.0	94.0
Fuchsin broth	78.4	76.1	85.8
Methylene blue-brom cresol purple broth	75.8	65.8	81.5
Brilliant green bile broth	75.0	72.3	76.9
Crystal violet broth	65.0	51.9	57.3
Formate ricinoleate broth	32.0	30.5	37.0

SUMMARY OF DATA

A preliminary report (3) on the data obtained in this study prior to May of this year has been presented elsewhere. Since that time additional data have been received from a few co-operators. In the earlier report comparative productivity indices of the various media were obtained on the basis of the most probable numbers calculated for the aggregate data. Since that time, the most probable numbers obtained with each individual test for all media have been calculated.

A comparison of the productivities of the trial media with standard lactose broth based on three methods of calculation are shown in table 2. The table shows that the percentages obtained by the three methods are in fair agreement and that the order of coli-

aerogenes productivity in all of them is not changed significantly. In method three the results with one strain isolated in Minnesota, which produced very low indices in all unbuffered media and very high indices in all buffered media, were not used. It is believed that for the purposes of comparative media study the other methods of obtaining mean productivity are more satisfactory.

The frequency with which the trial media produce various percentages of the lactose broth most probable numbers is shown in table 3. In a large series of tests, a medium which is equally productive of the coli-aerogenes group would produce results 50 per cent of which would be lower than standard lactose broth and 50

TABLE 3

Frequency with which trial media produce various percentages of standard lactose broth m.p.n's

TRIAL MEDIUM	TRIAL MEDIUM M.P.N. IN PERCENT OF STANDARD LACTOSE BROTH M.P.N.						
	Less than 10	Less than 20	Less than 30	Less than 50	Less than 70	Less than 100	100 or more
	Frequency of the indicated M.P.N. relation						
Buffered lactose broth	0	0	5.0	18.0	30.0	63.0	37.0
Fuchsin lactose broth	0	2.5	2.5	7.5	46.0	80.0	20.0
Brilliant green bile broth	0	3.0	5.0	20.0	54.0	80.0	20.0
Methylene blue-brom cresol purple broth	0	10.0	15.0	36.0	51.0	74.0	26.0
Crystal violet broth	5.0	13.0	25.0	46.0	68.0	85.0	15.0
Formate ricinoleate broth	17.0	40.0	55.0	74.0	83.0	91.0	9.0

per cent of which would be higher. None of these media produce results 50 per cent of which are higher than lactose broth. The least productive medium, formate ricinoleate, produces M.P.N.'s only 9 per cent of which are higher than lactose broth and the most productive, buffered lactose broth produces only 37 per cent that are higher than lactose broth. All of these media are underproductive when compared with standard lactose broth with the majority of the strains. The table does not show serious underproductivity for buffered lactose broth. Here frequencies of 5 for 30 per cent of the standard and 0 for 20 per cent of the standard are indicated. With methylene blue-brom cresol purple broth, however, the indi-

cations are that for every 100 tests at least 10 of them would show less than 20 per cent of the lactose broth index. This marked lowering of the indicated index might not be important in the case of raw waters, but on finished drinking waters where the Treasury Department Standard is involved, this lowering may become very important. Crystal violet broth and formate ricinoleate broth are even more underproductive at times; and as the table shows a frequency of 5 and 17 for these two media respectively, to show less than 10 per cent of the lactose broth M.P.N. is to be expected.

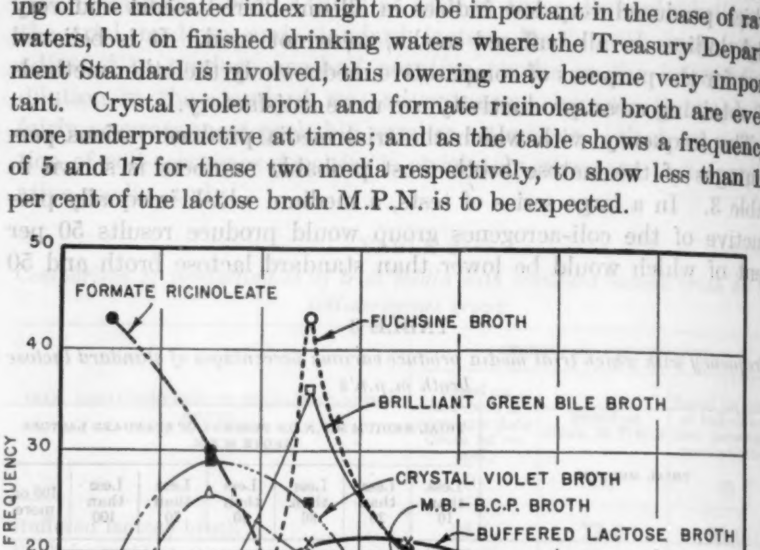


FIG. 1. FREQUENCY DISTRIBUTION OF TRIAL MEDIA M. P. N'S.

The frequency distribution of the trial media most probable numbers in percentage of the lactose broth most probable numbers is shown in figure 1. An examination of the figure indicates the underproductivity of all of these media and frequent very decided underproductivity of methylene blue-brom cresol purple broth, crystal violet broth and formate ricinoleate broth. On account of the underproductivity of these trial media with strains of coli-aerogenes isolated from water, they were not considered satisfactory for use as primary isolation media in place of lactose broth.

A study of the inhibitiveness of these media on lactose fermenting spore forming organisms, not members of the coli-aerogenes group, such as Cl. welchii, Cl. tertium, and B. aerosporus was also undertaken. The results indicated that buffered lactose broth was as good a medium for Cl. welchii and Cl. tertium and a better medium for B. aerosporus than standard lactose broth and is, therefore, even less selective than standard lactose broth.

Methylene blue-brom cresol purple is apparently a good medium for Cl. welchii and Cl. tertium and is in this respect not so desirable.

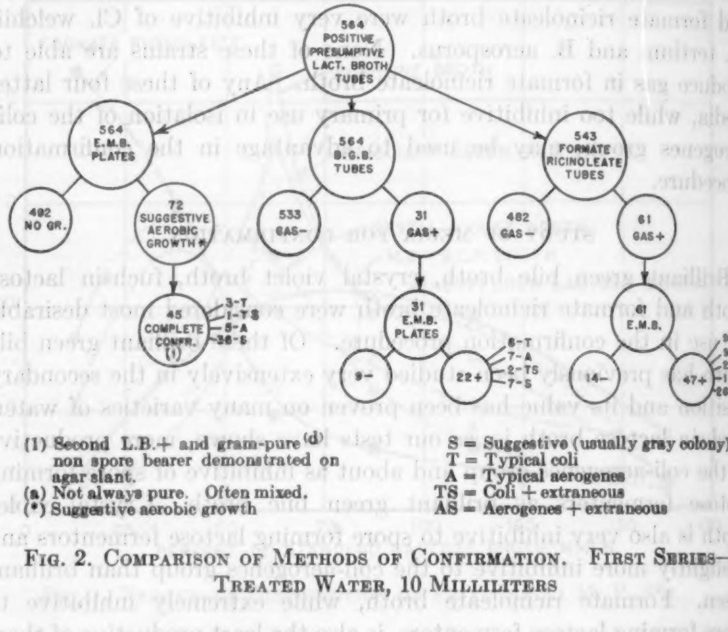
Brilliant green bile, crystal violet broth, fuchsin lactose broth and formate ricinoleate broth were very inhibitive of Cl. welchii, Cl. tertium and B. aerosporus. None of these strains are able to produce gas in formate ricinoleate broth. Any of these four latter media, while too inhibitive for primary use in isolation of the coli-aerogenes group, may be used to advantage in the confirmation procedure.

STUDY OF MEDIA FOR CONFIRMATION

Brilliant green bile broth, crystal violet broth, fuchsin lactose broth and formate ricinoleate broth were considered most desirable for use in the confirmation procedure. Of these brilliant green bile broth has previously been studied very extensively in the secondary position and its value has been proven on many varieties of water. Fuchsin lactose broth is, as our tests have shown, more productive of the coli-aerogenes group and about as inhibitive of spore forming lactose fermenters as brilliant green bile broth. Crystal violet broth is also very inhibitive to spore forming lactose fermentors and is slightly more inhibitive to the coli-aerogenes group than brilliant green. Formate ricinoleate broth, while extremely inhibitive to spore forming lactose fermentors, is also the least productive of these media for strains of the coli-aerogenes group. A preliminary experiment was carried out with the standard procedure in comparison with confirmation by the use of brilliant green bile broth and formate ricinoleate broth. This was to determine whether the difference in the reproductive qualities of these two media for the coli-aerogenes group was important in the secondary position. This series of tests were made by R. E. Noble of the Chicago Board of Health on finished chlorinated water samples from the pumping stations and the distribution system of the Chicago water supply. Chlorinated water

samples only were chosen for this experiment, for earlier studies by the Sanitary District of Chicago had indicated that the poorest checks by different methods of confirmation were always obtained on such samples. It is only where a very large number of samples of this kind are examined daily as at Chicago, that an opportunity for such a study is possible.

The results of this experiment are shown in figure 2. This figure is almost self explanatory. The arrows in the diagram indicate a transfer from one medium to another. The circles connected with



(1) Second L.B.+ and gram-pure (a) non spore bearer demonstrated on agar slant.
(a) Not always pure. Often mixed.
(*) Suggestive aerobic growth

S = Suggestive (usually gray colony)
T = Typical coli
A = Typical aerogenes
TS = Coli + extraneous
AS = Aerogenes + extraneous

FIG. 2. COMPARISON OF METHODS OF CONFIRMATION. FIRST SERIES—TREATED WATER, 10 MILLILITERS

lines without arrows to the previous circles indicate the results of the transfer. As shown in the figure, the positive gas tubes (any quantity of gas in 48 hours at 37°C.) obtained in the selective media were streaked on eosin methylene blue agar plates.

With the standard procedure, 72 partially confirmed tests on E.M.B. were obtained as compared to 31 positive gas brilliant green bile tubes and 61 positive gas formate ricinoleate tubes. By the standard procedure 45 positive confirmed coli-aerogenes results were obtained, which is 14 more than produced gas in brilliant green bile

and 16 less than produced gas in formate ricinoleate. Twenty-two of the 31 gas positive brilliant green bile tubes, or 71 percent, confirmed on E.M.B. plates; and 47 of the 61 gas positive formate ricinoleate tubes, or 77 percent, confirmed on E.M.B. plates. If the percentage of the lactose broth presumptives that were confirmed by these three methods are compared, the results are; standard procedure 8.0 percent, brilliant green bile 3.9 percent, and formate ricinoleate 8.3 percent. When the number of confirmations by the standard procedure is considered one hundred percent the brilliant green bile through E.M.B. method confirms only 49 percent and the formate ricinoleate through E.M.B. method confirms 104 percent. The brilliant green bile results on this experiment check previous comparisons made by the Sanitary District of Chicago on similar samples.

The results obtained with formate ricinoleate were interesting. The earlier study with coli-aerogenes strains indicated a lower productivity than brilliant green bile when small numbers of organisms are involved. Confirmation from lactose broth presumptives from chlorinated waters involves larger numbers of organisms which may retain an injury due to the effect of chlorination or may be injured due to the lowering of the pH or other changes in the lactose broth. This experiment seems to indicate that under these conditions, when larger numbers of organisms are involved, formate ricinoleate is more suitable and not as inhibitive as brilliant green bile broth to the coli-aerogenes group. It also indicated the fermentation of the formate ricinoleate broth by non members of the group other than spore forming lactose fermenters, and finally the possibility of more coli-aerogenes confirmations than are obtained by the standard procedure.

Another very similar experiment was, therefore, carried out in which complete confirmations from gas positive selective media tubes were made. MacConkey's[1] broth, as modified by Raghava Chari (4) was also included in these tests. Two separate groups of water samples were examined, the first included finished waters in which the residual chlorine was destroyed by the addition of a small amount

[1] Dr. Michael A. Farrell included MacConkey's medium in his coli-aerogenes productivity tests for the Committee. His results with 8 coli-aerogenes strains freshly isolated from water samples indicated that the productivity of this medium is of the order of brilliant green bile or M.B.-B.C.P. broth.

of sterile peptone solution at the time the collection was made, and the second, regular finished water samples that were collected and brought to the laboratory without neutralizing the residual chlorine. The results with the regular finished water samples having this residual chlorine unneutralized are shown in figure 3. The form of this diagram is similar to the first one and the lines and arrows have identical meanings. Complete confirmation as shown on the diagram means the demonstration of a gram negative non-spore-

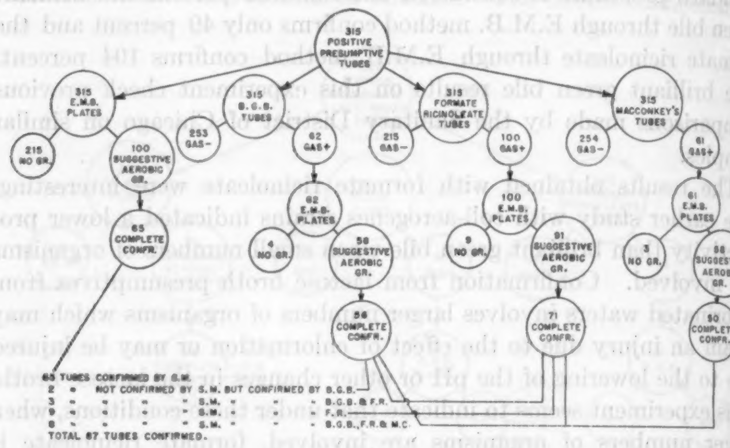


FIG. 3. RESULTS WITH 196 SAMPLES OF TREATED WATER. 315 POSITIVE PRESUMPTIVE TESTS IN LACTOSE BROTH, 87 TUBES CONFIRMED FOR COLI-AEROGENES GROUP BY VARIOUS METHODS

forming lactose fermenter. The number of complete confirmations and percentage of positive presumptives confirmed by the methods are as follows:

Method	*Number complete confirmations*	*Percent presumptives confirmed*
Standard	65	20.6
B. G. B.	56	17.8
Formate ricinoleate	71	22.5
MacConkey's	50	15.9

A careful study of these data indicated that no method of confirmation produced coli-aerogenes strains from all of the positive presumptive tubes that contained them. The data showed that at least 87, or 27.6 percent, of the positive presumptive tubes contained

coli-aerogenes strains. The percentages of this total which were confirmed by the various methods are as follows:

Formate ricinoleate	81.7
Standard	74.7
B. G. B.	64.4
MacConkey's	57.5

The numbers and diagram at the bottom of the chart indicate the distribution of coli-aerogenes complete confirmations that were made by the various procedures.

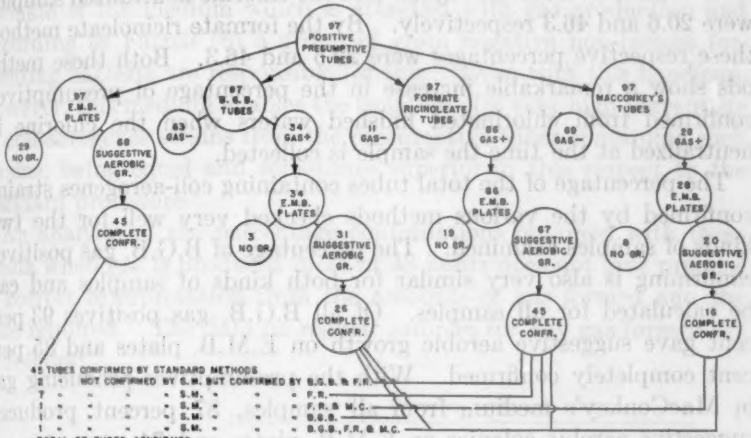


FIG. 4. RESULTS WITH 35 SAMPLES OF TREATED WATER PLUS BACTO PEPTONE TO NEUTRALIZE THE RESIDUAL CHLORINE. 97 POSITIVE PRESUMPTIVE TESTS IN LACTOSE BROTH, 57 TUBES CONFIRMED FOR THE COLI-AEROGENES GROUP BY VARIOUS METHODS

The results obtained with the samples on which the residual chlorine was neutralized are shown in figure 4. With these samples, the numbers and percentages of positive presumptives that were confirmed are as follows:

Method	*Number complete confirmations*	*Percent presumptives confirmed*
Standard	45	46.3
B. G. B.	26	26.8
Formate ricinoleate	45	46.3
MacConkey's	16	16.5

Again a greater number of presumptive tubes were found to contain coli-aerogenes strains than was shown by any single method of confirmation. The percentage of the total coli-aerogenes confirmations that were obtained by the various methods are as follows:

Standard	79.0
Formate ricinoleate	79.0
B. G. B.	45.6
MacConkey's	28.1

By the standard procedure the percentages of positive presumptives confirmed from the regular and the chlorine neutralized samples were 20.6 and 46.3 respectively. By the formate ricinoleate method these respective percentages were 22.5 and 46.3. Both these methods show a remarkable increase in the percentage of presumptives confirmed from chlorinated finished waters when the chlorine is neutralized at the time the sample is collected.

The percentage of the total tubes containing coli-aerogenes strains confirmed by the various methods checked very well for the two kinds of samples examined. The percentage of B.G.B. gas positives confirming is also very similar for both kinds of samples and can be calculated for all samples. Of all B.G.B. gas positives 93 percent gave suggestive aerobic growth on E.M.B. plates and 85 percent completely confirmed. With the presumptives producing gas in MacConkey's medium from all samples, 87 percent produced suggestive aerobic colonies on E.M.B. plates and 74 percent completely confirmed. With the formate ricinoleate, these figures are 85 percent giving suggestive aerobic growth and 62 percent completely confirming. With formate ricinoleate, however, the percentage of confirmations obtained from regular samples and chlorine neutralized samples do not check. For instance, with regular samples 71 percent of the formate ricinoleate gas positives completely confirmed, but with the chlorine neutralized water only 52 percent of the gas positives completely confirmed.

Going back one step it will be found that from regular samples only 100 of 315 lactose presumptives or 31.8 percent produced gas in formate ricinoleate, while from the chlorine neutralized samples 86 of 97 lactose presumptives or 88.7 percent fermented formate ricinoleate. This difference together with the fact that a much lower percentage of the formate ricinoleate positives were confirmed from chlorine neutralized samples may be interpreted as follows:

First, that the immediate neutralization when the samples are taken enables the isolation of organisms that are viable when the sample is taken, but could otherwise not be recovered; Second, that other organisms which ferment the formate ricinoleate broth but are not members of the coli-aerogenes group, and are not spore bearing lactose fermenters, are recovered by this neutralization. This all indicates that the formate ricinoleate medium while not fermented by spore forming lactose fermenters is fermented with gas production by non-lactose fermenters, not belonging to the coli-aerogenes group. According to Stark (5) it is the sodium formate of the medium which is attacked with gas production and according to Farrell (6) a group of gram negative non-lactose fermenting bacteria are responsible for this. Even with this handicap, however, this medium enables the isolation of a very high percentage of coli-aerogenes strains from the presumptive tubes containing such strains, being equal and sometimes superior in this respect to the standard procedure.

An analysis of the percentage confirmations obtained with these media when gas is produced in 24 or 48 hours does not give promise of correct interpretation from the amounts of gas formed and the time required. The data on regular samples for any gas formed are as follows:

	Percentage confirmed		
Gas formed in hours	*Formate ricinoleate*	*B. G. B.*	*MacConkey's*
24	75.9	100.0	78.6
48	52.4	71.4	89.5

Gas formed in 48 hours is almost as surely the indication of coli-aerogenes as gas formed in 24 hours. The percentages of tubes of these media showing only bubbles of gas in 48 hours, which completely confirmed for coli-aerogenes, are as follows:

	Percentage confirmed		
Gas formed	*Formate ricinoleate*	*B. G. B.*	*MacConkey's*
Bubble in 48 hrs.	50.0	68.4	94.4

This indicates that in no case can a bubble in 48 hours in these media be considered as caused by organisms other than coli-aerogenes. The safest rule is to consider any gas formed in 48 hours as a positive

indication of the group or actually make the confirmation. In general, the earlier the gas production in the brilliant green bile and formate ricinoleate, the greater is the chance that it is due to members of the coli-aerogenes group.

SUMMARY

1. A study of the coli-aerogenes productivity of various selective media was made. This indicated that all of the media were not sufficiently productive of this group as compared to standard lactose broth to be substituted for it as a primary medium. The productivity of the media from highest to lowest was as follows: Buffered lactose broth, fuchsin lactose broth, methylene blue-brom cresol purple broth, brilliant green bile broth, crystal violet broth and formate ricinoleate broth.

2. The media were examined for inhibitiveness to spore-bearing lactose fermenters. Of them all fuchsin lactose broth, brilliant green bile broth, crystal violet broth and formate ricinoleate broth were most effective for this purpose. Formate ricinoleate broth was by far the most inhibitive for these organisms.

3. A study was made of the use of formate ricinoleate broth, brilliant green bile broth and MacConkey's broth in the confirmation procedure in comparison with the standard procedure on finished chlorinated waters, where coli-aerogenes isolations are difficult. The results obtained with MacConkey's medium were unsatisfactory, though they cannot be considered conclusive because while the best American materials were used, English materials as used in the original were not obtainable. Brilliant green bile was quite satisfactory in that 75 percent of the tubes giving any gas in 48 hours confirmed. But on these samples the recovery of coli-aerogenes strains was only about 65 percent of the total which is about 10 percent under the recovery for the standard procedure. In the two sets of samples examined, the standard method only confirmed or recovered 74.7 and 79 percent of the coli-aerogenes positives from the presumptive tubes. This indicates that the standard procedure is far from a perfect method.

The formate ricinoleate method recovered 81.7 and 79 percent of the coli-aerogenes positives from the presumptive tubes. In respect to total recovery, it is the best procedure, but as only 62 percent of its gas positive tubes confirmed more labor is necessary, to get the completely confirmed results.

It should be remembered that the results given are obtained from water samples that are most difficult for checking coli-aerogenes isolations and that much more favorable results from these media would be expected from most untreated waters.

These studies should not be considered conclusive. Additional investigational work should be carried out and fuchsin lactose broth and crystal violet broth should be included.

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REPORT OF THE COMMITTEE ON WATER WORKS PRACTICE FOR THE YEAR ENDING JULY 1, 1935

Meetings of the committee were held May 6 and 8, 1935, at Cincinnati.

COMMITTEES ON THE MANUAL OF WATER WORKS PRACTICE

Committee 1, Basic Data. Committee previously discharged.

A. V. Ruggles, secretary of the Committee on Water Works Practice, issued a report on June 28, 1935, suggesting methods for collecting and recording, at the Association office, basic data of all the public water works systems, some 11,000 in number, in the United States.

Committee 2, Surface Water Allocation. No chairman appointed.

Committee 3, Surface Water Collection. It is with great sorrow that the committee records the death on June 22, 1935, of Weston Earle Fuller, the chairman of Committee 3, a civil engineer and waterworks man of highest character and attainments and for many years a devoted friend of many members of the Association.

Committee 4, Ground Water Collection. D. W. Mead, Chairman.

Committee 5, Quality and Treatment. Paul Hansen, Chairman. Text on this topic prepared with the help of sixty committee members is in the hands of the Chairman and is being revised to make it ready for publication and work remains to be done on preparation of diagrams to accompany the text. It is expected that all of this will be ready for publication before the end of 1935.

Committee 6, Power and Pumping. F. G. Cunningham, Chairman. Text on this topic has been prepared and work is to be done on tables and illustrations so that it may then be published.

Committee 7, Transmission and Distribution. G. Gale Dixon, Chairman. This committee is carrying on its work through thirteen subcommittees of which seven are organized and working.

In September, 1934, G. Gale Dixon, Chairman of Committee 7 on Transmission and Distribution, issued a 120 page report on Gate Valve Specifications, in which he presented a considerable amount of correspondence and discussion of the problems involved in Gate

Valve Specifications and a new draft of specifications for comparison with the draft prepared by Sub-Committee 7-E and transmitted by that committee in 1932 to Committee 7. This report of September, 1934, was sent to over seventy producers and consumers and received wide discussion and this discussion was also distributed among the same group of men. At the Cincinnati Convention of the American Water Works Association in 1935 a joint group of producers and consumers devoted a substantial part of several days to consideration of these specifications and at the close of the period covered by this report work was still under way.

Sub-Committee 7-A, Steel Plate Pipe for Water Supply. F. A. Barbour, Chairman, succeeded by L. P. Wood. No definite accomplishment during the year can be reported. For some years the committee has been deferring action pending the availability of the funds desirable for tests and adequate investigation.

In the late months of 1934 it was suggested to the committee that a specification for coating of steel pipe might be developed. At a meeting held in New York in January, 1935, it was decided that a tentative specification for steel plate pipe simply based on an evaluation of specifications recently used by competent engineers might be developed. To this end $1,000 of the funds allocated to the Water Works Practice Committee have been appropriated and an attempt is to be made to complete this tentative specification during the present year.

Mr. Leonard P. Wood in June, 1935, accepted the place of Chairman at the request of Mr. Barbour who will continue as a member of the committee.

Sub-Committee 7-B, Reinforced Concrete Pipe. No appointment made.

Sub-Committee 7-C, Cast Iron Pipe. No appointments are to be made at present in view of standing arrangements for coöperation with A-21, the Sectional Committee (under the American Standards Association) on Specifications for Cast Iron Pipe and Special Castings.

Sub-Committee 7-D, Laying Cast Iron Pipe. E. G. Bradbury, Chairman. At a meeting of the Committee on Water Works Practice at Cincinnati in May, 1935, there was discussion of the tentative specification and monograph on laying cast iron pipe which were submitted in June, 1933, to Chairman Dixon of Committee 7 by Chairman Bradbury of Sub-Committee 7-D. In the discussion at

this meeting the suggestion was made that it might be well to defer action on the Sub-Committee 7-D specification until findings are available from Sectional Committee A-21 (under the American Standards Association) on Specifications for Cast Iron Pipe. While awaiting these findings it is expected that some revisions will be made to the Sub-Committee 7-D draft.

Sub-Committee 7-E, Valves, Sluice Gates and Fire Hydrants. W. R. Conard, Chairman. The committee in 1933 submitted a first draft of specifications for fire hydrants to Chairman Dixon of Committee 7 but consideration of this draft has yielded to work on the specifications on Gate Valves.

Sub-Committee 7-F, Service Connections and Meters. J. E. Gibson, Chairman. The committee keeps in touch with current articles on service connections throughout United States and Canada and has taken cognizance of the recent demand on the part of some water works operators for a meter having a greater degree of refinement, particularly in the measurement of smaller streams. Specifications are to be prepared for service pipes of different kinds, copper, brass and others.

Sub-Committee 7-G, Location Records and Maintenance of Mains and Services. A. S. Hibbs, Chairman. A. R. O'Reilly and T. J. Skinker were appointed members of the sub-committee.

Sub-Committee 7-H, Steel Standpipes and Elevated Tanks. L. R. Howson, Chairman. Tentative Specifications for Steel Standpipes and Elevated Tanks were prepared by this sub-committee and published in the December, 1931, Journal of the Association with request for criticism. The committee gave consideration to the numerous suggestions which came in and has made some revisions in the specifications. Toward the close of the period covered by this report the specifications were revised in some respects and were published again in The Journal for November, 1935.

Sub-Committee 7-J, Distribution Reservoirs. No chairman appointed.

Sub-Committee 7-K, Water Consumption. No chairman appointed.

Sub-Committee 7-L, Fire Prevention and Protection. No chairman appointed.

Sub-Committee 7-M, Hydraulics of Distribution System. No chairman appointed.

Sub-Committee 7-T, Transite Pipe. C. R. Knowles, Chairman.

The committee reports progress on this subject. In assigning the subject to the committee it was suggested that consideration be given to the following features regarding Transite Pipe:

1. A history of the material as developed in Europe.
2. An assembly of experience in the practical use of the material in this country to date.
3. A study of such experimental data as may be developed by the tests of the Underwriters Laboratories and by the Associated Factory Mutual Fire Insurance Companies' Inspection Department.

At the time the committee was organized arrangements had been made by the manufacturers of the pipe to have laboratory tests made of the pipe at the Underwriters Laboratories and by the Associated Mutual Fire Insurance Companies' Inspection Department. Due to improvements in manufacturing methods these tests were held up. The investigations made by the laboratories thus far have been limited to the inspection of installations and observations as to the method of handling the pipe, application of couplings, cutting and pressure test after installations. Nothing has been done so far in the way of physical tests to determine the ultimate strength of the pipe in pressure tests, tensile or bending tests of the pipe or crushing tests on pipe samples.

It is expected that the laboratory tests on the pipe will be under way within the next sixty days and that the results of the tests will be available within the next ninety days.

The committee has collected a great deal of information in connection with this pipe as follows:

The number and location of plants manufacturing cement pipe in Europe.

Earliest installation of asbestos cement pipe.

Installations in various countries, including the mileage of installations and maximum and minimum sizes.

A list of notable installations in each country.

List of installations, the size and mileage in this country.

British standard specifications for asbestos-cement pipe.

Data in regard to field tests.

It is thought advisable, however, to defer any definite report until such time as the laboratory tests have been completed. Therefore, this report is merely one of progress.

Committee 8, Cross Connections. E. Sherman Chase, Chairman. Since presentation of its lengthy report of May 2, 1932, the committee has limited its activities to keeping itself reasonably well informed as to the status of laws and regulations relative to cross connections and as to instances of water supply pollution resulting from improper cross connections. The personnel of the committee has remained unchanged except that O. E. Brownell, Sanitary Engineer of the Minnesota Department of Health, has been added to its membership.

On September 20, 1934, C. W. Mowry, member of the committee, presented a short paper upon "Status of Cross Connection Regulations," before the New England Water Works Association. This paper constitutes an excellent summary of the cross connection situation and fairly represents conditions with respect to new developments since the 1932 report of the committee.

In general, it may be stated that more attention is being given to possible localized contamination of water supplies through faulty plumbing and water piping within buildings. The larger and more important cross connections between private and public water supplies are in general under fairly satisfactory control throughout the states of the Union. As is true, however, of all sanitary measures, the success of cross connection control depends on constant vigilance and the careful and thorough administration of regulations relating to such control.

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Committee 9, Relations to Consumers and Public. H. S. Morse, Chairman. The committee has been inactive during the year.

Committee 10, Valuation, Rate Making and Taxation. No chairman appointed.

Committee 11, Office Management, Records and Accounting. D. C. Grobbel, Chairman. No other appointments made.

Committee 12, Legal. No chairman appointed.

OTHER TECHNICAL COMMITTEES

Electrolysis and Electrical Interference. N. S. Hill, Jr., Chairman, E. E. Minor, M. W. Cowles and C. F. Meyerherm, Secretary.

The Committee on Electrolysis and Electrical Interference during the year ending June 30, 1935, confined its activities to consideration and discussion of Bare Neutral Interior Wiring and the proposed revisions of Article 9—Grounding, of the National Electrical Code. A representative of the Committee attended all meetings of the Code sub-committees which were considering these questions and several sessions of the Electrical Committee of the National Fire Protection Association at which the Code sub-committee reports were considered, adopted or modified.

In the Special Sub-committee on the use of Bare Neutral Interior Wiring Systems, consensus of opinion was so strongly against any extension of this form of wiring that the advocate of this extension of trial installations did not get a second to his motion to consider his report. The sub-committee's report did not completely represent the strength of this opposition to extension of this form of wiring but it did state that the committee recommended no further extension of trial installations.

In spite of this report, however, the Electrical Committee—on which by the way the water works interests have no vote—voted in favor of further extension of trial installations of bare neutral wiring, particularly in connection with range and water heater loads. This action contrary to its Sub-committee's report was made possible by a coalition of the voting strength of the Electrical Utilities and Manufacturer groups. This meant a nucleus of 14 votes and with a few additional individual votes constituted a sufficient majority to make the change possible. Subsequently, however, the Electrical Committee in a reconsideration of Article 5 on Methods of Wiring decided not to permit the use of bare neutral for hot water heater circuits and

to restrict its use to range circuits run with approved cable having a non-metallic outer covering. This, therefore, means that the neutral of these range circuits will have an outer covering of braid only, whereas in the ordinary approved insulated house wiring system both line conductor and neutral have a specified thickness of rubber insulation plus an outer braid.

In presenting their argument for extension of bare neutral wiring the Electrical utility group stressed the fact that even with the present approved wiring methods using insulated wires for all the conductors of the circuit, substantial and often large amounts of stray electric current flowed on water mains and pipes and therefore the water works interests should have no objection to Bare Neutral wiring which involves one or more insulated conductors, and a bare or uninsulated neutral or grounded conductor which can transfer stray current to the pipes at numerous points in the building wherever direct or accidental metallic contacts occur between the pipes and the electrical cable or conduit. They presented an Underwriters Laboratories' report, No. E11064, which definitely indicated the very general prevalence and excessive magnitude of stray electric currents occurring even with more or less carefully installed systems of bare neutral wiring. This report was very carefully reviewed by your Committee on Electrolysis and Electrical Interference and detailed comments and criticisms were sent to the sponsors of the investigation upon which the report was based and to the Chairman of the Electrical Committee and President of Underwriters Laboratories, Inc.

In view of the electrical utilities' open, insistent and persistent emphasis on the magnitude and general prevalence of stray current interchange between the electrical distribution system and house and street water pipes with existing approved types of wiring and the fact that the water works interests had taken so definite a stand in opposition to such stray currents even in their sanction of protective ground connections from electric systems to water pipes, your Committee on Electrolysis and Electrical Interference deemed it advisable not to attend further meetings of the Electrical Committee of the National Fire Protection Association in order not to give an implied or apparent acquiescence to the existence of these objectionable stray currents.

In addition your committee prepared a report on the situation

which was read at the Cincinnati convention of the American Water Works Association in May, 1935, and submitted a resolution revoking all sanction of ground connections from electrical systems to water pipes. This resolution was adopted by the Association at the Cincinnati convention, and the text of this report and resolution are printed with the convention proceedings.

With this official action as a matter of record, it is the opinion of your Committee on Electrolysis and Electrical Interference that the Chairman of the Electrical Committee of the National Fire Protection Association be officially notified of the American Water Works Association's opposition to electrical interconnections between water pipes and electric light and power systems.

It is also the opinion of your Committee on Electrolysis and Electrical Interference that Sectional Committee C-1 of the American Standards Association be officially notified of the foregoing action, and of the American Water Works Association opposition to the National Electrical Code because (a) this Code makes water pipe ground connections mandatory and it is now common knowledge that most of these grounds are of the current carrying and not the protective type; and (b) this Code now sanctions certain forms of Bare Neutral interior wiring and will probably extend such sanction to other forms of such wiring, all of which constitute a serious hazard and detriment to water works operators and the life and property of water works employees as well as water consumers.

The American Committee on Electrolysis, of which the American Water Works Association was one of the nine original sponsor societies, organized in 1913, was dissolved on June 1, 1935. Copies of the 204-page report of this committee, issued in 1921, may be purchased from the American Water Works Association, price one dollar.

Committee on Code for the Water Supply Industry. W. W. Brush, Chairman. It was evident early in the year covered by this report that sentiment of Association members was very strongly opposed to any code for the water supply industry and that there was little likelihood of a code being imposed by the Federal Government. At the suggestion of the chairman this committee was discharged in May, 1935.

Committee on Uniform Marking of Fire Hydrants to Indicate their Relative Fire Stream Capacity. S. H. Taylor, Chairman. This committee presented its report to the Cincinnati convention and some little discussion of it was had by the members. The question was raised as to whether any legal complications might follow the proposed markings to show the flow which might be expected. The chairman of your committee attended a meeting of the Committee on Water Works Practice during the convention and at the suggestion of that committee the members of the Committee on Uniform Marking of Hydrants are now giving further thought to the question raised and obtaining some legal opinions on that question.

Committee on Licensing Water Works Employees. L. V. Carpenter, Chairman. The committee was formed in September, 1934, and the committee work was handled by correspondence. As the first step, the chairman wrote each member of the committee suggesting a procedure for the committee to follow, then the present status of registration was submitted to each member of the committee in the form of a 50-page report. Questionnaires were sent to some 200 operators in the states which have licensing, to get their men's viewpoints on the feasibility of licensing. A tentative report was made up, and at the Cincinnati convention an open forum was held at which members of the Association were invited in to express their views, pro and con, on licensing. This material was submitted to the committee.

The chairman also appeared before the Committee on Water Works Practice and submitted copies of both the tentative report and the discussion.

The committee is making further studies and hopes to present its final report to the Board of Directors at the January, 1936, meeting.

Committee on Hazards to Plant and Personnel from Use of Chlorine and Other Chemicals. M. C. Smith, Chairman. At the Cincinnati convention of the Association in May, 1935, the committee presented a report on chlorine, published in the September, 1935, Journal. Reports will be prepared on Ammonia and such other chemicals as it is possible to cover.

JOINT COMMITTEES WITH OTHER ORGANIZATIONS

Joint Editorial Committee with American Public Health Association on Standard Methods for the Examination of Water and Sewage.

Members from A. W. W. A. Harry E. Jordan, Chairman, Wellington Donaldson and Wm. D. Hatfield.

Members from A. P. H. A. Arthur M. Buswell, John F. Norton and Sheppard T. Powell.

This report covers sales of the 7th edition and activities in preparation of the 8th edition of Standard Methods up to July 1, 1935.

1. 737 copies remain of the 5000 total printed of the 7th edition. It is evident that the current edition will be profitably out of print before the next edition is off the press.

2. All A. W. W. A. expense up to December 31, 1934, had been paid and a surplus of $498.10 transferred into our treasury. From the sale of 731 copies in the first half of 1935, all A. P. H. A. and A. W. W. A. expense was paid and a balance of $820.81 remained. Half of this accrues to the A. W. W. A.

3. Dr. Hatfield has completed the section on Sewage and it was published in the May, 1935, Sewage Works Journal. Changes indicated by criticism after this publication will be embodied in the text as printed in Standard Methods.

On June 18, 19 and 20, a conference of all the members of the committee, except Dr. Hatfield (who was in Mexico at the time) was held in Indianapolis. Detailed discussions of various features of the revision of text were carried on, and definite assignments for completion of various sections made to members of the committee.

The changes contemplated for the next edition are listed below.

The atomic weight table will be brought up to date.

The section on Turbidity will be rearranged and condensed.

The section on Color will be rewritten.

The result of Prof. Fair's and Mr. Spaulding's study of odor determinations will be brought into the text.

The text on Oxygen Consumed will be condensed.

The Residue on Evaporation text will be extended to include a section on "highly mineralized waters."

The section on Hardness will be rearranged and condensed.

The section on Zero Hardness will be dropped.

The "Acidity" determination will be revised.

A method for Residual Aluminum will be added.

The Chloride text will be revised.

The much discussed section on Chlorine will be revised and expanded to the end that this very important test is performed correctly under various types of interfering situations.

The sections on Lead, Zinc, Copper, Tin, will be revised and condensed if possible.

Changes in the Dissolved Oxygen text will be made as active workers in the field agree upon details.

The sections on Mineral Analysis and Boiler Water Analysis (pp. 65–79) were fully discussed. It was agreed that a general heading of Industrial Water Analysis would be used to include two divisions of material. The first "Municipal and Railroad Supplies" was assigned to Dr. Buswell. The second "Stationary Boiler Supplies" was assigned to Mr. Powell for development.

Mr. T. A. Olson has revised the section on Microscopic Methods. It has been studied by Prof. Fair, who developed the text in the current edition, and is approaching final form.

The section on Bacteriological methods is being developed under Dr. Norton's direction. With Mr. Ruchhoft's chairmanship, a committee of laboratory workers has studied in parallel the various selective planting media for Coli-Aerogenes group work, that have been in use in this country.

The outline of changes at present contemplated in the text of Standard Methods was presented in The Journal of September, 1935, page 1249.

Boiler Feed Water Studies Committee. In May, 1935, Sheppard T. Powell was succeeded by C. H. Fellows as chairman.

Sponsors. American Boiler Manufacturers Association, Association of American Railroads, American Society of Mechanical Engineers, American Society for Testing Materials, American Water Works Association and Edison Electric Institute.

A. W. W. A. Committee. Sheppard T. Powell, Chairman. Edward Bartow, Wellington Donaldson, C. R. Knowles and Abel Wolman.

During the period covered by this 1934–1935 Annual Report the activities of the Joint Research Committee on Boiler Feedwater Studies have been those involving the continued prosecution of the work in which its subcommittees were engaged during the preceding fiscal year. These will be reviewed briefly elsewhere in this report.

An important change in the organization of the committee has occurred as the result of the resignation of Sheppard T. Powell as Chairman. Mr. Powell, early in the past decade, perceived the

importance of extending the knowledge of the industry in the reactions between water and steel under the conditions obtaining as the temperature and pressure of boiler operation increased and organized the Joint Research Committee on Boiler Feedwater Studies. With the aid of leaders in the industries vitally interested in these studies, with whom he associated himself, a comprehensive program of research was outlined. Not all phases of the general problem were studied at once; but emphasis has been laid primarily on methods of analysis and on a study to determine the cause of foaming and priming. The interest stimulated by Mr. Powell's leadership however has, in the past ten years, advanced in a remarkable manner our knowledge of the reactions occurring within industrial water itself and between it and boiler metal under the conditions of association in modern steam power plants. It was with expressed regret that the members of the Executive Committee acceded to Mr. Powell's wishes and accepted his resignation.

The following named men were selected by the Executive Committee at its meeting in Cincinnati in May, 1935, to carry on the work of the Joint Research Committee on Boiler Feedwater Studies.

Chairman: C. H. Fellows, The Detroit Edison Company

Vice-Chairman: R. C. Bardwell, The Chesapeake & Ohio Railway Company

Secretary: J. B. Romer, The Babcock & Wilcox Company

These officers are planning a reorganization of the Joint Research Committee in an effort to stimulate increased financial interest in its work and, at the same time, further the objective originally drawn up.

During the past year the work of Technical Committee No. 8 on Methods of Boiler Water Analysis was continued. A progress report on the incompleted research program concerning methods for determining dissolved oxygen was presented before a session on Boiler Water at the Annual Meeting of the American Water Works Association, at Cincinnati in May, 1935.

The research work on the determination of dissolved oxygen undertaken by this Technical Committee has served to stimulate a number of other investigators in this field. As a result, there has been published to the benefit of industry the work of Swartz and Gurney, J. D. Yoder and his associates, D. O. Lima, and others.

Previously this Technical Committee has completed research work on methods of determining the hydroxide, carbonate, sulphate, and

phosphate ions in boiler feedwater and boiler water. The reports of these research projects have been distributed to members and sponsors of the main committee and were published in form for general distribution to the industry at large through the agency of the A. S. M. E. These reports have also been turned over to Committee D-19 of the A. S. T. M. for consideration and ultimate standardization.

The future work of Technical Committee No. 8 will be under the direction of Professor A. H. White of the University of Michigan. Professor White has accepted the invitation of the Executive Committee that he take the Chairmanship of this Technical Committee which was made vacant when its former Chairman was elected to the Chairmanship of the Main Committee.

The work of Technical Committee No. 3, dealing primarily with the causes and prevention of foaming and priming, has been temporarily discontinued. It is planned that this work will be resumed during the coming year.

The work of the special Technical Committee on Alkalinity and Sulphate Relations in Boiler Water Salines, under the direction of J. H. Walker, its chairman, has progressed to an important extent during the past year. The original objectives have been fulfilled and a report covering this work will be presented at the December, 1935, Meeting of the A. S. M. E.

In addition to this completed work, Mr. Walker's Committee has initiated more basic studies on the phenomenon of caustic embrittlement. Through the continued prosecution of these studies it is anticipated many new and important data will be disclosed regarding this subject, permitting a clearer understanding of its development and prevention.

Mr. Walker's report to the Joint Research Committee follows: *Committee on Alkalinity and Sulphate Relations in Boiler Water Salines.*—J. H. Walker, Chairman. This committee was organized to direct some research work on the solubility of sodium sulphate in the presence of the various other salts which are found in boiler water. It was felt that more accurate knowledge of these solubility relationships would make it possible to more accurately control boiler water conditions for protection against caustic embrittlement. There was no thought that the laboratory work would in itself supersede the A. S. M. E. recommendations for caustic embrittlement prevention, but the work was rather regarded as a foundation for the

refinement of those recommendations after being fully substantiated by operating experience.

The funds were obtained by solicitation from boiler users, concerns specializing in boiler feedwater treatment, and casualty insurance companies. The total amount of the funds was $17,850.00. The original program was laid out to cover an interval of two years, but since the rate of expenditure has been lower than estimated the work, which was started in 1932, will extend through 1935.

The project was placed at the New Brunswick Station of the United States Bureau of Mines in order to obtain the services of Dr. E. P. Partridge, whose excellent foundation and previous experience in work of this sort was highly desired. Dr. W. C. Schroeder, who had previously been associated with Dr. Partridge in similar work, has been actively engaged on the project since its inception.

The solubility of sodium sulphate in the presence of sodium hydroxide, sodium carbonate and sodium chloride has been accurately determined over a range of temperatures and thus the original objective has been fully carried out. The results have been reported in papers presented before the A. S. M. E. and have been distributed to the contributors to the fund. They furnish reliable data for the calculation of protective ratios according to the present accepted theory of the inhibition of caustic embrittlement by sodium sulphate.

With the balance of the fund, some more basic studies have been initiated of the embrittlement phenomena with the hope of throwing further light on the subject and possibly developing better methods of its prevention. It is unlikely that the remaining funds will suffice to completely clear up the matter and means are now being sought to continue the project.

Seven progress reports have been submitted to the Committee, most of which have been distributed to the contributors, and presented before the A. S. M. E. at its boiler feedwater sessions.

The personnel of the Committee is as follows: Messrs. Alex D. Bailey, R. C. Bardwell, R. E. Hall, D. B. Keyes, E. B. Powell, Sheppard T. Powell, T. E. Purcell, J. B. Romer, R. C. Stratton and C. H. Fellows (ex officio).

Committee on Water Hammer of the American Society of Mechanical Engineers.

A. W. W. A. Representatives—Thos. H. Wiggin, appointed in 1934, Frank M. Dawson, appointed in 1935.

Committee on Public Health of the National Association of Master Plumbers.

A. W. W. A. Representative—A. E. Gorman.

Construction League of the United States.

A. W. W. A. Representatives—Malcolm Pirnie; H. E. Jordan (1934), F. A. Barbour (1935); B. C. Little; Abel Wolman.

Nature and objectives of the league

The Construction League of the United States was formed in September, 1931 to create a medium for coördinated action within the construction industry. Its objectives as set forth in the League Regulations, are:

1. To create an agency truly representative of the whole industry through which to present the industry's viewpoint and needs to the public and the government.

2. To strengthen and benefit the industry internally by furnishing an agency to work out intra-industry problems.

3. To supply sound advice and criticism to the individual branches by common council and open forum of architects, engineers, general contractors, specialized contractors, producers and dealers.

4. To promote unified and coöperative plans of study, research and propaganda for the proper advancement of the construction industry in the best interests of the public.

Organization

MEMBERSHIP in the League is held by associations, national in character, the major services or products of whose individual members are utilized in the construction industry. Individual members of an association do not obtain a membership status by virtue of the membership of their association in the League. Their interests are represented by their association.

An ASSEMBLY of representatives of League members governs and operates the organization. Each member association is entitled to four representatives in the League Assembly.

The POLICY COMMITTEE determines and directs the affairs of the League between meetings of the League Assembly; its activities and powers include all matters commonly within the province of a board of directors. The Policy Committee includes the League officers, and two assemblymen, generally representative of the following branches of the industry: Architects, Engineers, General Con-

tractors (a builder and an engineering contractor), Sub-contractors (four representatives: two mechanical, two non-mechanical); Producers (a material and an equipment manufacturer); Fabricators (a material and an equipment representative), and Distributors (a material and a machinery representative), provided the respective branches are represented in the League Assembly.

The EXECUTIVE COMMITTEE of the Policy Committee consists of seven members, and is entrusted with execution of the League program between meetings of the Policy Committee.

The OFFICERS who conduct the affairs of the League are selected by the Assembly. They are: a General Chairman, two Vice Chairmen, a Treasurer and a General Secretary.

A JOINT SECRETARIAT of at least three members manages the office of the League and supervises its organization work: Secretariat is elected by the Assembly.

Until January, 1936, Malcolm Pirnie is First Vice Chairman of the League and a member of its Executive Committee, and was Chairman of the Special Legislative Committee.

On March 1 the Special Legislative Committee prepared several amendments to the Relief Act of 1935 designed to secure substantial allotments for useful public works to convert into permanent wealth the greater part of the 4,880 million dollar appropriation. These were presented to the President of the United States on March 2nd and he called the officers of the League for a conference at the White House on the afternoon of March 5th. As a result of the conference no further action on the proposed amendments was taken and it was the consensus of opinion that the appropriation would be administered to expedite the initiation and rapid execution of the many thousands of needed state, county and municipal public works projects known to exist.

At the request of the administration for recommendations of the League for conduct of construction under the Work Relief Act the League appointed a Special Committee on Work Relief Act with provision for four sub-committees, three representative of:

Architects and Engineers
Contractors (General and Special)
Manufacturers

and a fourth committee on

Classification and Qualification of the unemployed

The Executive Committee of the League approved the recommendations of the above committees and on April 11th The Construction Code Authority endorsed the principles of the recommendations and authorized its Executive Committee to coöperate with the League in developing its program.

On April 12 the resulting document containing:

A. Foreword on Principles
B. Report on Classification
C. Architects and Engineers Report
D. Contractors Brief
E. Manufacturers Brief
F. Architects Contract
G. Engineers Contract
H. Engineers Fee Basis
I. Engineers Salary Basis
J. Original Memorandum submitted to President Roosevelt, in February 1935

was issued by the League and placed in the hands of directors of various branches of the Administration dealing with construction.

By the latter part of June it was obvious that political expediencies had cast to the four winds any attempt to speed up a large program of sound useful public works. An effort was made to organize and finance a nationwide demand for allocation of the greater part of the 4,880 million dollar fund to normal construction activities on useful projects but although the Executive Committee created the "Committee on Useful Employment under the Work Relief Act" on June 28th, it soon became apparent that forces against such a principle were too strong to hope for any reasonable degree of success from this committee.

Membership of the American Water Works Association in the Construction League of the United States is a contribution for Construction Unity, the effectiveness of which is ably portrayed by Willard Chevalier in his editorial of May 9, 1935, in Engineering News-Record.

Participation of A. W. W. A. in the League should be continued. Appointment each year of Association representatives who will take active part in League activities, should be an important action of the January meeting of the Board of Directors.

Representatives on Committees of the National Fire Protection Association.

Electrical Code. Representative on Grounding (Article 9) Sub-Committee—Chas. F. Meyerherm.

See C-1, Sectional Committee (under the American Standards Association) on Electric Wiring and Apparatus in Relation to Fire Hazard, Regulations For.

See report herein under Committee on Electrolysis and Electrical Interference.

Forests. Edward E. Minor. In 1934 a report was published on Community Forest Fire Fighting Equipment, which can be purchased from the N. F. P. A., Boston, Mass. Since issuing this report the committee has been inactive.

Hydrants, Valves and Pipe Fittings. F. A. Barbour. A question has arisen with reference to the possibility of attaining uniformity in friction loss valves for hydrants, as specified by testing laboratories and the water works associations. The differences are not great and it is expected that agreement can be reached and a suggested valve incorporated in our Association rules as a performance requirement.

Public Water Supplies for Private Fire Protection. Nicholas S. Hill, Jr. The only matter on which there has been activity was the method of uniform marking of fire hydrants, to indicate their relative fire stream capacity, adopted by the New England Water Works Association and under consideration by the A. W. W. A. committee on that topic.

Tanks. Louis R. Howson. Consideration has been given to the inclusion of specifications covering the use of yellow pine in wood tanks and several smaller items such as revisions in the specifications for tank heating.

REPRESENTATIVES ON COMMITTEES OF THE AMERICAN STANDARDS ASSOCIATION

Annual reports in detail of the work of these committees are to be found in the files of the bulletins of the American Standards Association and of the Technical Reports of the American Society of Mechanical Engineers.

A-21, Cast Iron Pipe and Special Castings.—A. W. W. A. Representatives: T. H. Wiggin, Chairman of Sectional Committee; F. A.

Barbour, Wm. W. Brush, W. C. Hawley and Edw. E. Wall. (A. V. Ruggles acts as Executive Assistant to Chairman of this committee).

The annual report for 1934 was published in the June, 1935, Journal.

A-35, Manhole Frames and Covers. F. A. Marston. A revised edition of designs and specifications for standard manhole frames and covers will be submitted in the near future for approval. It is the belief of the Committee that these standard designs are suitable for the use of those who now have no standard designs of their own rather than with the expectation that all users of manhole frames and overs will change to the designs submitted by the Committee.

Unless some new criticisms arise that are not expected, the proposed standards should be approved shortly by the sponsor group and should then be forwarded to the American Standards Association for final action. The next step will be for the designs to be issued as a tentative standard.

It is probable therefore that the work of the Committee is nearing completion.

A-40, Plumbing Equipment. W. S. L. Cleverdon. Sub-committee No. 8 on Cast Iron Soil Pipe and Fittings, Mr. J. J. Crotty, chairman, during the year has completed the standard for Cast Iron Soil Pipe and Fittings. In May the proposed standard was submitted to the members of the Sectional Committee for vote on approval by letter ballot, this letter ballot vote being completed in July. After approval by the sponsors in August the proposed standard was transmitted to the American Standards Association in the same month.

Sub-committee No. 7 on Brass Fittings for Flared Copper Tubes authorized the submission of its standard to the members of the Sectional Committee in March, 1934, for vote on approval by letter ballot. This being favorable, the proposed standard is now before the sponsor organizations for approval and transmission to the American Standards Association.

B-2-1919, Pipe Threads. W. D. Sizer and Wm. W. Brush. An examination of our files indicates that no measurable progress has been made toward the completion of the report of Sub-committee No. 2 on Taper Pipe Threads. During the year, however, Chairman S. B. Terry has been endeavoring to reach a satisfactory decision on a certain problem involving the gaging of the taper thread. It

happens that just at this time an API committee is at work on a similar task in connection with the division of the API Line Pipe Work. The work of the API committee is practically completed so that the report of Sub-committee No. 2 which is now in type will soon be released to the members of the Sectional Committee for vote on approval by letter ballot.

B-16, Pipe Flanges and Fittings. Frank A. Barbour. Subcommittee No. 1 on Cast Iron Flanges and Flanged Fittings. During the process of taking a letter ballot vote on the Proposed American Standard for Ammonia Flanged Fittings and Companion Flanges for Maximum Service Pressure of 300 pounds per square inch (Gage) a considerable number of questions were raised, principally of an editorial nature, but nevertheless of sufficient importance to justify resubmitting the Standard to another letter ballot. A new draft of this Standard will be prepared and sent out again for letter ballot in the near future. It is anticipated that with the changes which will be made in the new draft, this standard will be approved by the Sectional Committee reasonably soon and then submitted to the Sponsors and the ASA for adoption as an American Standard.

Subcommittee No. 3 on Steel Flanges and Flanged Fittings. The Subgroup on Welding Flanges has made further progress on the Proposed American Standard for Steel Welding Neck Flanges, but this project is not yet ready for submission to the Sectional Committee for letter ballot vote.

Subcommittee No. 4 on Materials and Stresses. The letter ballot vote on the Proposed Addendum to American Steel Flanged Fittings Standard (B16e-1932) covering Pressure-Temperature Ratings and Hydrostatic Shell Test Pressures to replace Table I in the Introductory Notes of this Standard has been completed. The Addendum was approved by the Sectional Committee and by the three sponsors, namely, The American Society of Mechanical Engineers, Heating, Piping & Air Conditioning Contractors National Association and the Manufacturers Standardization Society of the Valve and Fittings Industry and has been recommended to the ASA for adoption as an Addendum to the Steel Flange Standard.

Another item which might be mentioned in this connection is the proposal by Mr. J. Hall Taylor, President, Taylor Forge and Pipe Works to Mr. H. H. Morgan, Chairman, A. S. T. M. Committee A-1, submitting a Proposed Specification for Forged Steel Flanges for

General Service. This proposal has been placed before Sub-committee No. 4, for consideration, by Chairman Houser because the changes in ASTM Specification A105 and the adoption by the ASTM of a new Specification for Forged Steel Flanges for General Service will necessarily require some revision of the Introductory Notes applying to Steel Forgings in the American Steel Flange Standard B16e-1932.

Subcommittee No. 5 on Face to Face Dimensions of Ferrous Flanged Valves. MSS "Standard Practice" No. SP-32 covering MSS Ferrous Flanged Valve Center-To-Face Standard has been favorably considered by Subcommittee No. 5, but before sending it to the Sectional Committee for adoption they referred it back to the MSS with several recommendations. Meanwhile further developments looking toward the standardization of additional lines of valves has taken place and it is expected that completion of this ASA Standard will be somewhat delayed in order that advantage may be taken of the work now being done on these additional lines.

Subcommittee No. 8 on Marking of Pipe Fittings. MSS "Standard Practice" No. SP-25 covering MSS Product Marking System for Valves and Fittings is under consideration by Subcommittee No. 8 as a basis for the formulation of a Proposed American Standard covering Marking. This matter of marking Valves and Fittings is extremely active at the present time, but the project is not ready for release by the Subcommittee.

B-31, Code for Pressure Piping. F. N. Speller. The Code for Pressure Piping, submitted to the Sectional Committee in 1934, was adopted by that committee in December, 1934. The Code covers Power, Gas and Air, Oil, and District Heating Piping, is in print as an American Tentative Standard and may be purchased from the American Society of Mechanical Engineers.

B-36, Wrought Iron and Wrought Steel Pipe and Tubing. F. N. Speller.

At the meeting of the Sectional Committee held on March 8, 1934, in Washington, a number of revisions to the January 1934 draft of the proposed standard on Wrought Iron and Wrought Steel Pipe were accepted.

Subject to these revisions the Standard was submitted during May 1934 to letter ballot of the Sectional Committee to secure

approval on recommending its adoption by the sponsors and the A.S.A. as a tentative American standard.

The result of this letter ballot was as follows:

Yes	35
No	1
Not voting	1
No reply	1
Total	38

The sponsors have approved the proposed standard and it is being submitted to the A. S. A. for approval in its present form.

With reference to specifications under date of December 12, 1932, a number of A. S. T. M. specifications covering tubular goods were referred to the Sectional Committee for reference to the American Standards Association for approval either as American Standards or American tentative standard. These specifications were approved by the A. S. A. on April 2, 1934. Three of these specifications were subsequently revised by action at the Annual Meeting of the A. S. T. M. in June 1934 or at the meeting of the A. S. T. M. Committee on Standards in August 1934—namely:

(1) A-106—Tentative Specifications for Lap Welded and Seamless Steel Pipe for High Temperature Service.

(2) A-136—Tentative Specifications for Forge Welded Steel Pipe.

(3) A-139—Tentative Specifications for Electric Fusion Welded Steel Pipe.

These were submitted to letter ballot for approval and submittal to A. S. A. for approval as American Standard in the case of A-136 and as American Tentative Standards in the case of A-106 and A-139.

There was no formal report presented at the Annual Meeting of A. S. T. M. in June, 1935, principally because these several matters had been submitted to A. S. A. for approval, but advice concerning such approval had not as yet been received. It is understood from the Secretary that these matters are expected to be adjusted within the next few weeks.

C-1, Electric Wiring and Apparatus in Relation to Fire Hazard, Regulations For. See report herein under Committee on Electrolysis and Electrical Interference.

Representative of A. W. W. A. on Article 9, Committee on Grounding of Electrical Code Committee—Charles F. Meyerherm.

G-8, Zinc Coating of Iron and Steel. R. S. Dean and R. C. Ewry. The only meeting of the Sectional Committee on Zinc Coating of Iron and Steel, which includes Technical Committee IV on Pipes and Their Fittings, held during the year was on March 7, 1935, at Philadelphia, Pa., in connection with the spring group committee meetings of the American Society for Testing Materials. At this meeting the sectional committee gave consideration to a report of its Executive Committee which called attention to methods followed in recent years to develop specifications and methods of tests on zinc coating. The sectional committee recognized that a considerable degree of duplication had resulted between the personnel and activities of the technical committees of the sectional committee, and Committee A-5 of the ASTM and the latter's subcommittees. Following discussion, the Executive Committee of the sectional committee was authorized to draft new rules for procedure, which would retain the principle of organizational membership in the sectional committee but would provide for closer coördination of activities of individual projects and thus avoid a duplication of the program between the subcommittees of ASTM Committee A-5 and the technical committees of the sectional committee.

Technical Committee IV on Pipes and Their Fittings (J. A. Capp, Acting Chairman).—Following consideration in previous years of the Tentative Specifications for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses (ASTM: A120-28T), the technical committee gave attention to the revised edition of these specifications, which were published by the Society in 1934. In the preparation of the revised specifications several details previously recommended by the technical committee had been incorporated. Following the report the Sectional Committee voted to submit specifications (A120-34T) to letter ballot action of the sectional committee on the question of its submittal to the ASA for approval as American Tentative Standard.

Z-23, Sieves for Testing Purposes. Gordon M. Fair. Practically all items of the proposed sieve specification have been at least informally agreed upon in the technical subcommittees except those pertaining to the coarse woven wire sieves and the round-hole sieves. The chairman of the coarse sieve committee hopes to be able to com-

plete the work of his committee within the next month. After a meeting of the executive committee, the matter will probably then be in shape for the general committee to meet and take final action.

COMMITTEE ON WATER WORKS PRACTICE
FRANK A. BARBOUR
R. K. BLANCHARD
F. G. CUNNINGHAM
W. W. DEBERARD
JAMES E. GIBSON
ARTHUR E. GORMAN
GEORGE W. PRACY
A. U. SANDERSON
ABEL WOLMAN
MALCOLM PIRNIE, *Chairman.*

A. V. RUGGLES, *Secretary.*

LIST OF SECTION PAPERS

New York Section

Rochester, New York, October 17–18, 1935

Minnesota Section

St. Paul, Minnesota, October 18–19, 1935

Piping, Valves and Fittings on Boiler Room Equipment.....W. A. Dallach
Progress of Work and Method of Treatment to be Used by Minneapolis-St. Paul Sanitary District........................George A. Schroepfer
Pitometer Trunk Line Survey in St. Paul..............Leonard N. Thompson
Activated Carbon and Its Various Properties..................Arthur Welch
Discussion on Plant and Office Practice:

1. Service Pipes, Layout, Materials....................Edgar W. Johnson
2. Water meters, reading, servicing, repairs, testing and ownership Eugene Schwarz
3. Distribution System, Maintenance, Leaks, Repairs to Gates and Hydrants..Henry Magnus
4. Customer Inquiry Procedure, Complaints, Delinquencies and Adjustments..J. C. Flanagan
5. Service Leakage Control, Follow Up Notice and Repairs...Felix Seligman

New Jersey Section

New Brunswick, New Jersey, October 30, 1935

Some Friends and Some Enemies in Our Drinking Water...Dr. T. E. Nelson

California Section

San Diego, California, October 23–26, 1935

Municipal Water Softening....................................Eskel Nordell
The Metropolitan Aqueduct of Southern California (Illustrated) Franklin Thomas
The San Diego Water Supply..................................Fred D. Pyle
Practical Problems in Water Distribution...............E. W. Breitkreutz
Back Siphoning and Cross Connections........................G. E. Arnold
Design of Distribution Systems to Meet Requirements of Board of Fire Underwriters.......................................Robert E. Andrews
The Effect of Recent Court Decisions on Water Rights.....T. B. Cosgrove
Treatment of the Colorado River Water....................D. M. Forrester
Purification of City Water Supply of Vallejo.........Wm. E. Wentworth
New Method of Application of Copper Sulphate to Reservoirs...R. F. Goudey
Plankton Control of Morris Reservoir..........................C. W. Sopp
Activated Carbon Plant at Culver City.......................C. P. Harnish

15th Annual Joint Convention
North Carolina Section, A. W. W. A. and North Carolina Sewage Works Association

Durham, North Carolina, November 4–6, 1935

Operating Costs at the Greensboro Separate Sludge Digestion-Trickling Filter Sewage Treatment...................................W. M. Lybrook
The Spindal Sewage Treatment Plant.........................Harwood Beebe
Sewage Treatment Plant Beautification (Illustrated).........M. W. Tatlock

North Carolina Laws Relating to Municipal Water Works and Sewerage Systems..Prof. T. S. Johnson
Symposium on the Grounding of Electrical Systems to Municipal Water Supply Distribution Systems:
(a) Paper by a representative of the Cast Iron Pipe Research Association
(b) Paper by a representative of the General Electric Company
(c) Three minute discussions by representatives of municipalities and probably one electrical utility company official. Speakers to be selected later.
Government Land Use Planning as it Relates to Watersheds
Dr. Paul C. Wager
North Carolina Rainfall..Lee A. Denson
Some Experiences in Purifying Water from Impounding Reservoirs at Durham
Wm. M. Franklin
Water Purification Difficulties Attributable to Spore Forming Bacteria and a High Concentration of Organic Matter........................P. W. Frisk
Motion Pictures of Microscopic Aquatic Life..................John B. Hawley
Experimental Determination of the Depth of Filter Bed Sand and its Relation to the Effective Size of Sand..................Dr. Meredith Thompson
Dangerous Plumbing Cross Connections (Illustrated with Motion Pictures)
D. S. Abell

Wisconsin Section

Sheboygan, Wisconsin, November 4–6, 1935

Is Your Water Supply Adequate?
(a) For Fire Protection Purposes..............................J. B. Wilkinson
(b) For Domestic and Industrial Purposes......................Jerry Donohue
Statistical Comparisons for Water Departments of Wisconsin Cities
E. W. Morehouse
Developing Shallow Well Supplies..............................W. G. Kirchoffer
Development of Deep Well Supplies.............................W. B. Reinick
Pumping Deep Wells..C. N. Ward
Trends in Water Purification..........................Prof. Jack J. Hinman, Jr.
Interesting Features of Milwaukee Filter Plant...............Herbert Schmitt
Purification Plant at Two Rivers...............................E. J. Donnelly
Round Table Discussion of Filter Plant Operation. Led by Jerome C. Zufeld
Manufacture and Laying of Transite Pipe (Movies)...............A. C. Wilson
Round Table Discussion of Distribution System:
(a) Maintenance.......................................Led by C. P. Gross
(b) Records..Led by C. S. Gruetzmacher
Safeguarding Water Supplies from the Source to the Consumer
A. E. Gorman
Some Mutual Interests of Waterworks and Health Officials....L. F. Warrick
Report of Committee on Licensing of Waterworks Operators...W. U. Gallaher
Improving the Mineral Quality of Municipal Water Supplies by Softening
C. P. Hoover

ABSTRACTS OF WATER WORKS LITERATURE

FRANK HANNAN

Key: American Journal of Public Health, 12: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Behavior of Oxidizing Agents with Activated Carbon. A. S. BEHRMAN and H. GUSTAFSON. Ind. Eng. Chem., *27*: 426–9, April, 1935. Adsorption of oxidizing agents by activated carbon may be followed by: (1) Catalytic decomposition of oxidizing agent, e.g., hydrogen peroxide. (2) Reaction of oxidizing agent with carbon with: (*a*) release of reaction products from carbon, e.g., dechlorination of water; (*b*) retention of at least one reaction product in carbon, e.g., decolorization of potassium permanganate. (3) Retention of oxidizing agent without chemical reaction with carbon, e.g., iodine. Processes and products involving these phenomena are discussed.—*Selma Gottlieb.*

Water Problems in Sulfur Mining. C. E. BUTTERWORTH. Ind. Eng. Chem., *27*: 548–55, May, 1935. In FRASCH method, sulfur is melted *in situ* by water superheated to from 300° to 320°F. Use of brine from sulfur formations is impracticable, because of scale formation. Very soft water is needed for high pressure boilers. At Newgulf plant of Texas Gulf Sulphur (sic) Company, San Bernard River water, with well water when needed, is softened at about 200°F. with lime and little or no soda ash, and filtered through calcite bed after 1 hour sedimentation. At this temperature, magnesium is satisfactorily precipitated without excess lime, but excess soda ash is needed for calcium. Ferrous sulfate, used as coagulant, also removes last traces of dissolved oxygen. Sodium sulfate is used to prevent caustic embrittlement in boilers and sodium metaphosphate for residual calcium. In heat insulated steel line several thousand feet long, supplying 320°F. water to mines, scale was removed with inhibited hydrochloric acid followed by mechanical removal of siliceous sludge. Bleed water (formation water plus fresh water supplied for melting sulfur) must be removed to prevent excessive underground pressures. Before disposal into river, hydrogen sulfide is removed by countercurrent scrubbing with flue gas in redwood tanks, phosphate and sulfite being added to prevent deposition of calcium carbonate and sulfur respectively.—*Selma Gottlieb.*

Turbidimetric Determination of Sulfate in Water. Betz-Hellige Method. R. T. SHEEN, H. L. KAHLER and E. M. ROSS. Ind. Eng. Chem., Anal. Ed., 7: 4, 262–5, 1935. Turbidimeter used compares a beam of light with Tyndall effect produced from lateral illumination of sample by same light source. Re-

agents are barium chloride crystals, hydrochloric acid, and sodium chloride. Using different light filter plates in turbidimeter, 0–5, 0–15, 0–50 and 0–100 p.p.m. of sulfate can be determined, results comparing favorably with gravimetric determinations. Ions ordinarily present in water do not interfere. Determination can be made in ten minutes. Method is recommended for boiler and feed-water studies.—*Selma Gottlieb.*

Analytical Properties of Commercial Sulfated Alcohols. FRANK M. BIFFEN and FOSTER DEE SNELL. Ind. Eng. Chem., Anal. Ed., **7**: 4, 234–7, 1935. In mixed solutions, sodium alkyl sulfates (newly developed soap-like compounds) are hard to differentiate from soaps and sulfonated oils. If factor for alkyl radical can be accurately estimated, either HART, or benzidine, method for sulfate gives quantitative results, former even in presence of soap. Loss at 110°C. gives approximation even in presence of moderate amounts of soap and/or sulfonated oil. Other methods tried were less successful. Much work remains to be done on subject.—*Selma Gottlieb.*

Colorimetric Methods for the Determination of Phosphorus. CH. ZINZADZE. Ind. Eng. Chem., Anal. Ed., **7**: 4, 227–30, 1935. Detailed directions are given for preparation of stable, reliable reagents for both molybdenum blue (I) and reduction (II) methods. II does not require heating and is slightly more sensitive to small quantities of phosphorus pentoxide, but blue color is not stable, as with I. Gum arabic prevents turbidity when using stannous chloride as reducing agent in II. Several organic reducing agents are also listed. Proper acid to molybdenum blue ratio eliminates interference of silica, and sodium sulfite eliminates trouble from arsenates, nitrates, and ferric iron.—*Selma Gottlieb.*

Comparative Results of the Bacteriological Examination of Madras Waters at the Source and After Transport to a Distant Laboratory. W. J. WEBSTER and T. N. S. RAGHAVACHARI. Ind. J. Med. Research, 23: 57–68, July, 1935. Standard practice at King Institute, where samples are received for examination from all parts of Madras Presidency, is for such samples to be shipped packed in ice. To determine whether this is necessary, 104 duplicate samples were examined in course of 2 years, one of each being shipped in ice and other exposed to prevailing atmospheric temperature. In addition, in 75 cases, tubes of MACCONKEY broth were inoculated for "lactose fermenters" test at point of collection and conveyed to laboratory in portable incubator at 37°C. Detailed tabulations are given of results of these comparative tests, which clearly indicate that un-iced samples tend to show lower agar count and smaller numbers and fewer species of lactose fermenters. Seventy-five per cent showed fewer lactose fermenters in un-iced samples, difference in practically every case being 1 tube in geometric series. In 19 instances (18.3 percent) test for true coli was confirmed in iced portion and not in un-iced portion. In one case this was reversed. Failure to confirm occurs but rarely in routine practice. In 16 cases out of 75, sample examined at point of collection showed lactose fermenters in smaller quantities of water then did iced sample, differ-

ence in each case being 1 tube. With respect to species of coli isolated, there was no significant difference. It is concluded that when direct inoculation at sampling point is impracticable, trouble and expense of icing is entirely justified. Un-iced sample cannot be accepted as substitute for fresh, or chilled, sample.—*R. E. Thompson.*

The Logic of Universal Metering. Maurice P. Davidson. The American City, 50: 5, 63–64, May 1935. Spirited plea for universal metering in New York City. Stresses need for reducing waste, if restrictions on consumption are to be avoided pending next large development; claims that metering could reduce consumption by 200 m.g. daily, or 20 percent; and instances other savings which would ensue, such as reduced pumping costs.—*Arthur P. Miller.*

An Automatic Softening Plant for Utica's Water Supply. Anon. The American City, 50: 5, 65–66, May 1935. One of the two sources of water for Utica, N. Y. is the Graefenburg group of springs, with combined flow of 750,000 gallons per day and hardness varying seasonally from 150 to 500 p.p.m. Recent improvements provide for treating this water by means of two Permutit softeners 9 feet in diameter and 8 feet high, a pressure sand filter, a chlorinator and an ammoniator. Softening is automatically controlled, as is carefully explained. Salt recovery is an important part of the process.—*Arthur P. Miller.*

Preserving the Artesian Water Supply of Honolulu. Anon. The American City, 50: 5, 71, May 1935. Draft on artesian wells supplying Honolulu became alarming in 1926. In 1929 legislature created Board of Water Supply. Board's first policy was 100% metering. Legislature cancelled all free water privileges and Board adopted self-supporting rates. Consumption was by various means brought down to a figure considered reasonable for a sub-tropical city and waste was reduced. Artesian cap rock filters the water and no typhoid fever has ever been laid to its charge.—*Arthur P. Miller.*

Iron and Manganese Removal at Lincoln, Nebraska. D. L. Erickson. The American City, 50: 5, 75–76, May 1935. After one year's use of newly acquired additional water supply, Lincoln, Nebraska, suddenly awoke to the fact that its new supply contained manganese. This was first known appearance of manganese in objectionable quantities in Nebraska ground waters. Steps were taken to acquire iron and manganese removal plant, ultimate adaptation of which to include complete water softening was kept steadily in mind. Processes to be used include coke tray aëration; upward flow contact filtration through either manganese ore, coke, or gravel; sedimentation; and rapid sand filtration.—*Arthur P. Miller.*

Water Departments Should Pay Their Way. Orville C. Butler. The American City, 50: 6, 46, June 1935. This article recommends that cost of fire protection at Niagara Falls, N. Y., should be a charge against the entire

community and included in tax levy. Remaining revenue required by water department should be derived from water consumers by applying suitable rate schedule.—*Arthur P. Miller.*

Making the Most of Meter Readers. ORVILLE C. BUTLER. The American City, 50: 7, 48–49, July 1935. Work of meter readers in Niagara Falls, N. Y., was stepped up from 57 to 150 meters per day. With time still left on their hands, scheme was worked out whereby meter readers delivered the bills, saving postage. Still having spare time, their instructions were changed to include check on stopped meters. This expedited repair of faulty meters and reduced loss of revenue. A further check on meter seals revealed that 800 were either missing or broken. Yet further, meter readers now check and recheck on high consumption, to locate its source.—*Arthur P. Miller.*

More Care Needed in Picking Water-Supply Sources. PAUL HANSEN. The American City, 50: 7, 49, July 1935. Selection of water sources must be made with greater care than in the past. Increasing pollution places increasing burdens on purification works; hence the natural desire for sources least polluted. Droughts of 1930 and 1934 served to emphasize need of circumspection in selection of water sources.—*Arthur P. Miller.*

An Underground Dam Impounds Water for Harrisonburg, Virginia. ALLEN B. McDANIEL. The American City, 50: 7, 61–62, July 1935. In 1934, Harrisonburg, Virginia, improved its water supply by constructing unique groundwater collecting system. Submerged dam has been built across Dry River valley about one-quarter mile above surface water intake works. Its length is 913 feet and its height above the valley floor ranges from 10 to 22 feet. Collecting gallery along upstream face of dam and collecting pipe lines are included. Backfill on upstream side of dam was made with selected stone. Dam intercepts about 850,000 gallons per day, any excess being retained in natural underground reservoir extending for one-half mile up valley floor.—*Arthur P. Miller.*

Water Department Handicapped by Free Services and Unpaid Bills. WILLIAM TROTTIER. The American City, 50: 8, 43, August 1935. Lowell, Massachusetts, water department's revenues have been decreasing since 1923. In February 1935 it had a surplus of $18,000.00 and accounts receivable of about $54,500.00. Careful operation to live within revenues has been forced on the department and more attention to judicious financial policy has become essential.—*Arthur P. Miller.*

Adequate Record of Underground Structures of a Water System. E. A. MUNYAN. The American City, 50: 8, 57–59, August 1935. Every water department should keep a proper record of its underground properties and should keep this record current. Much money can be saved by eliminating useless digging and hunting for underground works and much goodwill can be gained by reducing delays in service and traffic. This article describes the charts,

maps, and cards used by a large water utility to keep an accurate record of its underground water lines, valves, and other permanent installations.—*Arthur P. Miller.*

A Survey of the Ground Water Resources of Illinois. Illinois State Water Survey Circular 18: 1935. 6 x 9 inches, paper. 47 pp. Reports results of survey carried out under the authority of the CWA and discusses nearly 50,000 well records and 1250 analyses, assembled and made from 100 counties for this purpose. Review of data indicates that marked recessions of ground water levels have occurred within period of available records and that wide variations in quality are to be found within relatively short distances. Constitutes a valuable addition to hydrology of the state.—*R. L. McNamee.*

Soap Usage and Water Hardness. H. W. HUDSON. Illinois State Water Survey Circular 13: 1934. 8½ x 11 inches, paper. 4 pp. Reprinted from "Water Works Engineering," January 10, 1934. Market surveys of retail soap sales at Chicago Heights, Bloomington, and Champaign-Urbana, Illinois, and at Superior, Wisconsin, indicate that almost any city supplied with surface waters requiring filtration and containing appreciable amounts of mineral matter can well afford softening. Data given are too detailed for quotation here, but should be referred to by those interested in the field of water softening, since this is the most recent and thorough analysis of the economic benefits of softening.—*R. L. McNamee.*

Data on the Ground Waters of Lake County, Illinois. Illinois State Water Survey Circular 17: 1935. 6 x 9 inches, paper. 65 pp. This is a thorough inventory of area covered, containing discussions of engineering data, of field observations, and of chemical analytical data, together with detailed tabulations on over 600 wells penetrating five aquifers.—*R. L. McNamee.*

Building a New Water Supply under PWA Auspices. FARLEY GANNETT. Eng. News-Rec., 112: 690–2, May 31, 1934. Detailed account of trials and tribulations of Shippensburg, Pa., in building 11-mile pipe line, the first PWA project in Pennsylvania. For years this town, which has population of 7,500, had obtained its supply from "South Mountain" during wet weather and from limestone spring during dry weather. New supply is drawn from "North Mountain," where several large streams originating in thinly inhabited region will furnish adequate supply for an almost indefinite period. Total cost, including intake, 11-mile 12-inch cement-lined cast iron pipe line, chlorinator, etc. was $148,000.—*R. E. Thompson.*

Water Distribution System Strengthened at Pittsburgh. Eng. News-Rec., 112: 687–8, May 31, 1934. Extensive program of distribution system improvements has been undertaken in Pittsburgh, with aid of CWA labor, which includes replacement of about 15 miles of old and inadequate mains, repair of 3 large feeder mains, new supply main to secondary pumping station, and new high-pressure main connecting two pumping stations. The 3 steel feeder

mains had been badly damaged by electrolysis and soil corrosion and are being repaired by patching with steel plate and protected from further damage by encasement in 12 inches of reinforced concrete.—*R. E. Thompson.*

Relief Labor Utilized to Recondition Water System. S. M. VAN LOAN. Eng. News-Rec. 112, 689, May 31, 1934. Number of improvements were undertaken in Philadelphia under CWA, including inspection and reconditioning of 49,500 gate valves in distribution system, painting of fire hydrants, revision of distribution system records, repair of main leaks, and restoration of, and improvements to, filter plant equipment which had been postponed owing to financial conditions.—*R. E. Thompson.*

Plant Capacity Raised by Bettering Operation. MARSDEN C. SMITH. Eng. News-Rec., 112: 688–9, May 31, 1934. Effective capacity of purification plant at Richmond, Va., has been increased at least 50 percent and water of better quality produced at lower cost by improvements in method of preparing water for filtration. Plant improvements have included installation of low-lift pump to maintain adequate operating head during periods of low water, contruction of diversion dam, 700 feet long, to increase available head and minimize use of electric power for low-lift pumping, development of "flocculator" type mechanical mixer, and installation of hoist and monorail to handle 1-ton chlorine containers. Revised operating procedure has included continuous, instead of seasonal, treatment for control of algae in raw water settling basins, pH control of coagulation by addition by lime or acid prior to coagulant, taste control by use of activated carbon fed in batch at beginning of filter runs directly to filters, use of ammonia-chlorine for sterilization, and correction of pH for reduction of corrosiveness by aëration and chemical treatment. Increased purification efficiency is shown in brief tabulation.—*R. E. Thompson.*

Abandoned Coal Mines Sealed to Prevent Acid Seepage into Stream. Eng. News-Rec., 112: 743, June 7, 1934. According to report by E. S. TISDALE, more than 1200 abandoned coal mines in West Virginia have been sealed during past few months as CWA project. There remain at least 3000 more to be sealed. It is estimated that one mine was discharging as much as 12,000 pounds sulfuric acid solution daily. From 1 to 3 years will be required for complete return of waste waters from mines to alkaline condition, but tangible results are already apparent. In one case, acid content of seepage water dropped 25 per cent within 3 weeks after sealing. In another instance, drainage had become alkaline. Procedure consists of constructing walls of concrete, brick, or stone, with trap at bottom to exclude air, across mouth of each drift. Seals do not interfere with drainage or outflow of seepage water.—*R. E. Thompson.*

Russia Creates a Great Laboratory for Hydraulic Research. I. GUTMANN. Eng. News-Rec., 112: 761–6, June 14, 1934. Review of organization and activities of The Scientific Research Institute of Hydrotechnics, a U. S. S. R. institution formed in 1931 by merger of 11 fully equipped hydraulic laboratories.

Since that time, new laboratory building has been constructed in Leningrad to house 9 new research laboratories, bringing total to 20. Staff consists of 421 men and women, including 150 scientifically trained technicians, engineers, and professors. Appropriation in 1933 for institute, which is largest hydraulic research institution in world, was 2,520,000 rubles.—*R. E. Thompson.*

Flood Probability Formula Modified to Simplify Application. C. R. Pettis. Eng. News-Rec., 112: 804–5, June 21, 1934. As result of study of all official records of run-off published by United States Geological Survey and unofficial records in current literature, author has modified "width" formula for probable 100-year flood developed by him in connection with flood control study at Wilkes-Barre, Pa., in 1927. Statistical evidence available indicates that probable 1000-year flood is about 20 per cent greater than probable 100-year flood, probable 10,000-year flood about 30 percent greater, and maximum flood of authoritative record (20,000 years) about 35 per cent greater.—*R. E. Thompson.*

Large Refund by Water Company Ordered by State Commission. Eng. News-Rec., 112: 850, June 28, 1934. Refunds to consumers aggregating about $3,000,000 have been ordered by Pennsylvania Public Service Commission to be paid by Scranton-Springbrook Water Service Company. Refunds are payments for water service collected since July 1, 1928, controversy re rates having been under way since that date. Company has been allowed four years in which to make refunds. Company supplies water to number of communities in Scranton region.—*R. E. Thompson.*

Bouquet Canyon Dam Built for Los Angeles Aqueduct. H. L. Jacques. Eng. News-Rec., 112: 810–3, June 21, 1934. To provide additional storage along Los Angeles Aqueduct for water supply emergencies and to equalize flow for power production, Department of Water and Power, Los Angeles, has just completed Bouquet Canyon Dam. The 36,000-acre-foot reservoir is located about 50 miles from city on small stream with negligible run-off which will not be utilized. It will be filled and discharged through 3.5-mile pipe line connecting with aqueduct at head of penstock to San Francisquito No. 1 power plant. Storage provided will replace the 38,000-acre-feet lost when St. Francis Dam failed in 1928. Main structure is rolled earthfill with height 185 feet above streambed, crest length of 1200 feet, and side slopes of 3 to 1 on both faces, upstream face being paved with reinforced concrete. Pipe line, 18,200 feet long and 80 to 94 inches in diameter, was electrically welded throughout.—*R. E. Thompson.*

Land Sections, Hetch Hetchy Pipe Line. Eng. News-Rec., 112: 855, June 28, 1934. Unit prices of low bidders on 20 miles of land sections of Bay Pipeline Crossing No. 2 of Hetch Hetchy project, San Francisco, are given. Line will be made up of welded steel pipe and steel-cylinder-reinforced concrete pipe. Contract was awarded for $2,371,227.—*R. E. Thompson.*

Engineering Aspects of the Present Midwest Drought. Eng. News-Rec., **112**: 834–5, June 28, 1934. Precipitation less than half of normal during first 5 months of year over 12 states in Middle West has produced most extensive drought in climatological history of United States, resulting in widespread depletion of stream flow over entire Midwest Section, and continued and accumulated lowering of ground water levels.—*R. E. Thompson.*

Retrogression of Levels in River Beds Below Dams. E. W. LANE. Eng. News-Rec., **112**: 836–8, June 28, 1934. Experience in regard to retrogression of levels below dams built across streams having beds of movable material is reviewed and possible effects of this phenomenon at Boulder Dam is discussed. Flow passing dam, having been partly relieved of load of suspended matter, will pick up material from river bed below dam with resulting retrogression of bed level. **Continuous Records Are Needed in the Study of Retrogression.** L. F. HARZA. Ibid., 838. **Experience with Bed Degradation Below Dams in European Rivers.** SAMUEL SHULITS. Ibid., 838–9. **Load Recovery Theory Applied to Yellow River Flood Control.** ARTHUR M. SHAW. Ibid., 839–40. Discussion of possibiliy of utilizing phenomenon of bed retrogression below dams, in flood control.—*R. E. Thompson.*

Large Concrete Structure Launched Like a Ship. JOHN G. AHLERS. Eng. News-Rec., **113**: 38–40, July 12, 1934. Box of reinforced concrete, 32 x 52 feet in area and 16 feet high, weighing 530 tons, comprising inlet well, foundation, and lower part of pump house at Grasselli Chemical Company plant at Grasselli, N. J., was recently constructed on edge of Kill van Kull by somewhat unusual method. Built ashore on launching ways, it was slid into water and towed 3 miles to plant site, where it was sunk into position on previously prepared timber-pile supports. Use of cofferdam was not considered practical, since bottom of structure was to be placed 19 feet below high water. Details of operations involved are included.—*R. E. Thompson.*

Trailer for Moving 185-Ton Units of Boulder Dam Penstock Pipe. Eng. News-Rec., **113**: 47, July 12, 1934. Brief illustrated description of trailer, to be drawn by tractors, designed for transportation of pipe sections, ranging up to 30 feet in diameter and weighing as much as 185 tons, 1.5 miles from desert fabricating plant to site of erection.—*R. E. Thompson.*

Twelve-Foot Precast Concrete Pipe for Little Morongo Siphon. RICHARD B. WARD. Eng. News-Rec., **113**: 33–5, July 12, 1934. Along 241-mile aqueduct being constructed by Metropolitan Water District of Southern California to bring Colorado River water to Los Angeles metropolitan area there will be 150 inverted siphons ranging in length from 300 to 26,300 feet, with total lengths of about 27 miles. Those having lengths of less than 400 feet and static heads less than 20 feet are to be built of monolithic concrete, either as one 16-foot pipe, or as three 9-foot 9-inch square boxes, depending on adjoining structures. Those exceeding these limits will be constructed in 2-barrel units of: (1) 12-foot precast concrete; (2) 12-foot 4-inch monolithic concrete; or (3) 12-foot 4-inch

steel pipe. As aid in comparing relative merits of precast and monolithic concrete, district is making 2 trial installations. Details of pipe sections for precast Little Morongo siphon are given.—*R. E. Thompson.*

Municipal Water Rates. Arthur M. Shaw. Eng. News-Rec., **113**: 87, July 19, 1934. Writer points out that while a "readiness-to-serve" charge is undebatable in some utility rates, situation is somewhat different in case of water and sewer service. Health of community may depend not merely upon having made the securing of such service possible for all residents, but upon having made it mandatory for them. In at least one city (New Orleans), itemized quarterly statement begins with item of "free water." All services are metered, but estimated amount for operation of 1 sanitary toilet is deducted from bill. Writer believes that every inducement should be made to insure use of safe water supply and of connection with sanitary sewer.—*R. E. Thompson.*

Continuing Drought Cuts Water Supplies and Sets New Low Water Records. Eng. News-Rec., **113**: 152, 156, August 2, 1934. Outline of effect of present drought on water supply and stream flow.—*R. E. Thompson.*

Raw Water Used at Dresden to Increase Ground Supply. C. Martin Riedel. Eng. News-Rec., **112**: 569–70, 1934. Dresden, on the Elbe River, has population of about 620,000. Since 1873, water supply has been derived from wells adjacent to river, daily consumption being about 38 gallons per capita. River water already contains manganese, more of which is dissolved in passage through the soil, bringing total content up to 1.5 p.p.m. in collected water. After treatment with lime, to form protective coating on mains, water is pumped into pressure tanks containing coarse sand in voids of which is dense growth of manganese bacteria, which satisfactorily remove all manganese. To meet increasing demands for water, capacity of suburban Hosterwitz works has been considerably increased by "groundwater enrichment." Water from river is pumped into open concrete settling tanks providing minimum retention of 4 hours, which removes from 30 to 60 percent of suspended matter. After rapid sand filtration, water enters ground water basin through infiltration basins (sprinkling filters) containing an 8-inch layer of sand. Around these basins, at a distance of about 200 feet from their outer walls, is a row of tubular wells, water from which is drawn through long suction lines into suction well at filter plant, whence it passes through lime treatment and demanganization tanks.—*R. E. Thompson (Courtesy Chem. Abst.).*

Surplus Earnings of Water Plants May Be Used for City Debt. Eng. News-Rec., **113**: 191, August 9, 1934. Ruling of state attorney-general permits city officials of Carthage, Missouri, to apply surplus earnings of municipal water plant to other city use by proper ordinance, provided that such transfer does not endanger ability to meet all interest and principal payments on bonds issued against utility. It is stressed that maintenance of water rates at higher

than necessary level for purpose of raising revenue for other purposes is not approved of.—*R. E. Thompson.*

New Devices and Materials Used to Better Economy and Reliability. F. G. Cunningham. Eng. News-Rec., **113:** 335–6, 1934. Improved practice includes mechanical mixing, more extensive instrumentation, and increased flexibility and reliability.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Driving 91 Miles of Tunnels on the Colorado River Aqueduct. R. M. Merriman. Eng. News-Rec., **113:** 97–105, July 26, 1934. Work on the 29 tunnels, totaling 91.72 miles in length, the controlling factor in completion of 241-mile aqueduct being built by Metropolitan District of Southern California at cost of $220,000,000 is well under way. Roads, water systems, telephone lines, camps, and hospitals have been built and driving of tunnels started. Completion of lined tunnels is scheduled for 1938. For most part, tunnels are uniformly 16 feet in finished diameter. Concrete lining will be used throughout, rough excavation being made to 18-foot diameter. Standard tunnel grade is 3.432 feet per mile, giving maximum capacity of 1,605 second-feet. Methods and equipment, working conditions, nature of material encountered, and rate of progress are dealt with in detail.—*R. E. Thompson.*

Similitude Requirements in Model Design. Roy W. Carlson. Eng. News-Rec., **113:** 235–8, August 23, 1934. Discussion of model design, in which it is shown that for entire field of models, only 2 rules are required to define necessary and sufficient conditions for dynamic and static similitude, namely: (1) model shall be geometrically similar to its prototype, except as to dimensions which do not affect the behaviour of the model; and (2) force scale-reduction factor shall be the same for forces arising from each of the various influences. **Similitude in Hydraulic Models.** K. C. Reynolds. Eng. News-Rec. **113:** 238, August 23, 1934. Discussion of Prof. Carlson's article.—*R. E. Thompson.*

Experimental Water Plant Gives Great Flexibility. Harold Vagtborg and T. J. Westerberg. Eng. News-Rec., **113:** 338–40, 1934. Illustrated description of 25-gallon-per-minute experimental purification plant recently installed at Armour Institute of Technology to facilitate research on methods of water treatment. The plant was designed with ample flexibility for a wide range of studies, including provision for altering quality of raw water supply, derived either from well points, or from Chicago distribution system, by addition of suitable materials.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Intense Local Rain Breaks Dams and Floods City in South New Jersey Tidewater Area. Eng. News-Rec., **113:** 189, 192–3, August 9, 1934. Following rainfall of 7.22 inches in 12.5 hours, concentrated in small area in southwestern New Jersey, local flood on August 3 swept out several small earth dams on Cohansey River and converged on city of Bridgeton, wrecking the municipal water supply and destroying 3 bridges. City was without water

for 22 hours. Several years ago, artesian well supply was abandoned in favor of lake supply, taking water from canal a half mile below dam. Two old artesian wells had been restored to service 22 hours after disruption of supply, providing 1.6 m.g.d., sufficient for domestic use only. Three fire engines and a 2000-g.p.m. pump were later used for pumping additional water from river to supply industries. All water was heavily chlorinated in addition to normal filtration. Repair of dam was commenced August 4th and dam was expected to be ready for service by August 9th, but some time will be required for lake to refill and thus restore normal water service.—*R. E. Thompson.*

Velocity-Head Correction for Hydraulic Flow. MORROUGH P. O'BRIEN and JOE W. JOHNSON. Eng. News-Rec., **113**: 214–6, August 16, 1934. Discussion of computation of velocity-head in problems of flow in open channels.—*R. E. Thompson.*

Concrete-Placing Details at Boulder Dam. Eng. News-Rec., **113**: 71, July 19, 1934. Brief illustrated description. Vibrators are used around edges of blocks, to ensure working of concrete into corners of forms. Combined air and water jet is used in preparing construction joints for next pour. This is carried out when curing has proceeded to point where small percentage of surface will be loosened and cut away by jetting, leaving sharply broken surface that is ideal for effective bonding. Joints made by this procedure when tested in shear averaged 92 percent of strength of concrete itself.—*R. E. Thompson.*

Welding a 78-Inch Steel Supply Line for Seattle Water Department. G. W. DESELLEM. Eng. News-Rec., **113**: 204–5, August 16, 1934. Seattle has installed several pipe lines of welded steel design, most recent of which involved replacing of 29,000 feet of 78-inch line from Cedar River Reservoir to Lake Youngs, being city's first concrete-coated, all-welded steel pipe line. Pipe was fabricated of alternate in-and-out courses of 78-inch and 78⅜-inch inside diameter sections, resolving welding into following classes: (1) one longitudinal shop butt-joint in each section; (2) two circumferential shop lap-joints (welded inside and out) per 32-foot unit; (3) miscellaneous shop tack welds; (4) one circumferential lap-joint (welded inside and out) in field at assembly of each unit. Procedure is outlined. After testing, pipe was thoroughly cleaned and painted inside with hot primer, after which coating of hot enamel was centrifugally applied, pipe being rotated at about 40 r.p.m. Concrete covering, consisting of 3 parts (wet concrete, reinforcing wire mesh, and outside layer of coarse cloth), was applied in form of ribbon, spirally wrapped as pipe was slowly rotated between centers of large lathe-like machine. Coating was cured for about 30 hours before shipment.—*R. E. Thompson.*

From the Sierra to San Francisco. Eng. News-Rec., **113**: August 2, 1934. Group of articles presenting composite picture of essential elements of San Francisco's Hetch Hetchy project. **A Foreword.** M. M. O'SHAUGHNESSY. 130. Brief statement of early difficulties in connection with project, which

will be completed and ready for service in September. **San Francisco's Water Supply.** 131–4. Historical summary of development of San Francisco's water supply. Power production was begun in August, 1925, offsetting interest on that part of project built long in advance of delivery of water. Total cost of construction of Hetch Hetchy water and power system will be practically $100,000,000, including about $10,500,000 interest during construction. For this investment, city will have system that, with slight further construction, will be ample for population of 4,000,000 and will eventually reduce water rates of 36¢ per 1000 gallons by about one-half. **How the Hetch Hetchy Aqueduct was Planned and Built.** L. T. McAfee. 134–41. Work of building dams, tunnels, power houses, and pipe lines is reviewed. Aqueduct proper begins at Early intake, 12 miles down Tuolumne River from largest of storage reservoirs, and from this point extends 138 miles to Crystal Springs Reservoir, on San Francisco Peninsula. Eventually aqueduct will be continued to receiving reservoir in city, bypassing Crystal Springs. Entire watershed, which begins in divide of Sierra Nevada, contains not one single permanent habitation. Only one main road traverses area and mountains north of river are accessible only by rough trails. Construction power system consists of Lake Eleanor Dam, Cherry River aqueduct, Cherry Power House, and 33 miles of transmission lines. Eleanor Dam is multiple-arch concrete structure, 1260 feet long and 70 feet high. Reservoir has capacity of 28,000 acre-feet, which is far from adequate to impound runoff. At future date, rockfill dam to impound 218,000, or more, acre-feet is to be constructed. O'Shaughnessy Dam, largest single item of project, is concrete dam of arched gravity type, 226.5 feet high above river level and 118 below to deepest point of cutoff trench, and 600 feet long on crest, containing 400,000 cubic yards concrete. Plans call for increasing height by 80 feet. From dam, water now flows down natural channel of Tuolumne River to Early intake. Ultimately, flow will be through tunnel and 60,000-h.p. hydro-electric plant. At Early intake, beginning of aqueduct proper, is concrete-arch diversion dam, 81 feet high and 262 feet long. Mountain division tunnel, 19 miles long, from Early intake to Priest River, consists of 7.5 miles of unlined tunnel (13½ x 13½ feet) and 11.5 miles of horseshoe shape, concrete-lined tunnel (10¼ x 10¼ feet). Mocassin Division includes Priest Reservoir, power tunnel, penstock pipes, and Mocassin power house. Priest Dam is an earth- and rockfill, 1160 feet long and 147.5 feet high. Leaving power house, water enters Mocassin reregulating reservoir, which serves to equalize flow in aqueduct. Dam is 855 feet long and 50 feet high, consisting largely of earth fill. Foothill Division tunnel starts at Mocassin plant and continues westerly 5.2 miles to crossing of canyon of Tuolumne River at Red Mountain Bar in steel pipe 9.5 feet in diameter and 2400 feet long. This siphon is of interest because of hinged type of pipe support. Tunnel units have same dimensions as Mountain tunnel. Aqueduct connecting west portal of foothill tunnels and east portal of Coast Range tunnel, consists of 47.5 miles of steel pipe, ranging in diameter from 56 to 66 inches. Feature of this work was concrete mortar wrapping of steel pipe sections as protection against corrosive ground water. By far the most difficult unit of entire project was the 25-mile section of 10.5-foot tunnel

through Coast Range. Plans called for parallel twin bore when required. Tunnel penetrates range of mountains which is geologically young and which has been squeezed and contorted until it is probably 2 miles shorter than in its original state. Gunite, up to 36 inches thick, was placed as soon as tunneling was completed. Quicksand proved very troublesome in some few cases and hydrogen sulfide and methane were encountered. Hydrogen sulfide caused temporary blindness when absorbed into blood stream and one explosion of methane occurred, causing 12 deaths. Present submarine pipe line crossing southern end of San Francisco Bay is to be duplicated, involving construction of 3 submerged pipe lines 42 inches in diameter and 0.5 mile long at Dumbarton Strait and 20.7 miles of 5.5-foot pipe. Article is replete with illustrations, and with cost and progress data. **Operating the Hetch Hetchy Aqueduct and Planning for the Future.** 141-3. Plan of Hetch Hetchy system provides for ultimate delivery of 400 m.g.d., which is sufficient for needs of from 4 to 5 million people on basis of present demand rate. Daily consumption from existing sources approximates 50 m.g.d. The several units of aqueduct have capacities ranging from 400 down to 45 m.g.d. in the pipes where instalment construction was economically feasible. The 2 mountain reservoirs, Hetch Hetchy and Lake Eleanor, are developed to furnish safe yield estimated at 200 to 250 m.g.d. When both dams have been raised, combined storage of 578,500 acre-feet is believed sufficient, even through dry-year cycles, to maintain aqueduct at its 400-m.g.d. capacity. Under present operating conditions water is drawn from Hetch Hetchy storage to full capacity of aqueduct (about 750 second-feet) to develop maximum amount of power at Mocassin plant and obtain maximum revenue. As result, no hold-over storage is maintained. Work of enlarging dam, it is expected, will be commenced this summer. Delivery of Hetch Hetchy water will result in gradual increase in storage in peninsula impounding reservoirs of water department, which during present summer again gave promise of being depleted to dangerous level. Although their capacity, including Calaveras Reservoir on east side of Bay, is about 60,000 m.g., or more than 3 years' supply for city, at end of 1933-4 rainy season they were storing only 16,000 m.g., or somewhat less than one year's supply. To avoid possibility of interruption of supply by rupture of pipe lines from latter reservoirs to city, campaign is being carried on to increase intra-city storage to 1000 m.g. by construction of 3 reservoirs. Work on smallest of these was begun under CWA auspices last winter. Construction of 2 additional city reservoirs as part of program authorized in 1933 will vastly improve situation. Analysis of water from Hetch Hetchy reservoir shows 14.8 p.p.m. total solids and 2.58 p.p.m. hardness. Hardness of water from present sources averages about 100 p.p.m. Raker Act specifically provides sanitary protection of watershed, should it become necessary. No treatment is planned for Hetch Hetchy supply, except usual chlorination after it leaves local reservoirs en route to city. **Hetch Hetchy Water Rights Complicated by Unusual Claims.** 143-6. Controversies and litigation over diversion of Hetch Hetchy water by San Francisco are reviewed and discussed. Not one legal opposition has been carried through to final decision by highest state court. General trend of court action has been to give less substance to

conflicting claims; to tend to lessen (in some cases to eliminate) claims that would obstruct city's program of developing adequate water supply. Prominent legal authorities believe that California water law and its interpretation thus far render city substantially secure against successful challenge of its full use of Hetch Hetchy aqueduct. **Bibliography.** 146. List of 151 articles published in Engineering Record, Engineering News, and, after their consolidation, in Engineering News-Record, on San Francisco water supply since 1910.—*R. E. Thompson.*

New Engineering Achievement in the Western States. Eng. News-Rec., **113**: 147-9, August 2, 1934. Tribute to quality of work involved in major engineering works under construction in west, including Colorado River aqueduct and Boulder Dam project of Metropolitan Water District of Southern California.—*R. E. Thompson.*

Problems in Using Government Data on Rainfall and Runoff. C. H. Eiffert. Eng. News-Rec., **113**: 200-1, August 16, 1934. Suggested that data published by United States Weather Bureau, Geological Survey, and Corps of Engineers could be co-ordinated to advantage for engineering use, e.g., by making all rainfall observations, at least in same state or district, at same hour, publication of data regarding beginning and end of each rain, locating stream gaging stations of different organizations to better advantage in relation to one another, and standardization of rating methods and of form in which data are published.—*R. E. Thompson.*

Importance of Rainfall Records. Robert L. Lowry, Jr. Eng. News-Rec., **113**: 309, September 6, 1934. Discussion supporting C. H. Eiffert (cf. previous abstract). Value of uniform distribution of rainfall stations and of continuity of records is stressed.—*R. E. Thompson.*

New Index Recommended for Filter Efficiency. Roberts Hulbert and Douglas Feben. Eng. News-Rec., **113**: 423, 1934. As result of observations on series of trial runs of 5 rapid sand filters at Detroit, Mich., it is concluded that quantity of water filtered per foot loss in head is a more logical index of filter performance than the commonly employed value, length of filter run.—*R. E. Thompson (Courtesy Chem. Abst.).*

Pumping Equipment for Water Works and Sewage Plants. P. L. Evans. Engineering and Cont. Rec., **48**: 751-3, September 12, 1934. Brief, general discussion of electricaly-driven pumps for water and sewage plants, deep well installations, etc.—*R. E. Thompson.*

Removal and Salvage of Old Submarine Water Pipes Under the First Narrows at Vancouver. Eng. News-Rec., **113**: 265, August 30, 1934. Four lines of 18-inch, and 2 lines of 12-inch, cast iron pipe are being removed from First Narrows of Burrard Inlet, Vancouver, B. C. They were taken out of service recently on completion of 7½-foot rock-tunnel siphon line, construction of

which was undertaken immediately after steamer collision resulted in breakage of 4 of 6 submarine lines. Previously, pipes had been damaged on several occasions by fouling anchors. Value of lead in joints, which amounts to as much as 300 pounds per joint in larger pipes, is expected to cover cost of removal. In addition, pipe sections have considerable salvage value.—*R. E. Thompson.*

Colorado Springs Water Supply Line. Eng. News-Rec., **113**: 546, October 25, 1934. Unit prices given from 3 lowest bidders on 9,532 feet of 5- x 7-foot pipe tunnel for Colorado Springs, Colorado. Pipe line, located in mountains on slope of Pike's Peak, runs from South Catamount Reservoir (El. 9160) to Cascades Creek (El. 7314). Construction is of steel pipe with plain ends, joints being of Dresser and Dayton type. Contract was awarded for $260,621. —*R. E. Thompson.*

Better Facilities Now Provided for Pretreatment and Filter Washing. L. R. Howson. Eng. News-Rec., **113**: 337–8, 1934. Principal advancement in filter plant design has been more adequate provision for conditioning filter influent and for washing filters. The flocculator type of mixer has been found very efficient. Settling basins are being designed of shallower depth, with better diffusion at inlets and greater care to impede short-circuiting. Where conditions require deep basins, two-storey coagulation is being employed. This effects some saving in construction cost and provides better settling.—*R. E. Thompson (Courtesy Chem. Abst.).*

Broad Study of Droughts Urged by Australian Engineer. W. R. Baldwin-Wiseman. Eng. News-Rec., **113**: 377, September 20, 1934. Brief discussion of world-wide drought conditions. Method developed by author and described in recent paper, "The cartographic study of drought," before Royal Meteorological Society, to be published in third issue of their Quarterly Journal, overcomes some difficulties encountered in study of droughts. If, as suggested by Ellsworth Huntington, there is a climatic pulse of about 640 years (roughly 57 times the duration of the 11.2-year sunspot cycle), the 4th dry period since beginning of Christian era should culminate about 2010, in which case we are probably now entering upon period of more frequently occurring drought not unlike those in first, eighth, and fourteenth centuries. Study of situation is therefore essential.—*R. E. Thompson.*

Study of Weather Records Fails to Reveal Long-Range Cycles. Eng. News-Rec., **113**: 46–7, July 12, 1934. Conclusions, based on studies made by United States Weather Bureau, presented by J. B. Kineer at meeting of American Meteorological Society, are reviewed. Investigation showed conclusively that not one weather cycle, aside from the annual, has any practical value as means of long-range weather forecasting in United States. Comparison of records for suggested cycles of 11, 23, and 35 years indicated that forecasts would have been wrong over 50 per cent of time.—*R. E. Thompson.*

New England Textile Mill Instals Complete Water Purification Plant. E. SHERMAN CHASE. Eng. News-Rec., 113; 337, 1934. Very brief description of plant consisting of complete rapid sand filtration and zeolite softening units.—*R. E. Thompson (Courtesy Chem. Abst.).*

Cross-Connections in Municipal Water Supplies in Ontario. G. A. H. BURN and E. W. JOHNSTON. Can. Pub. Health J., 25: 218–24, 1934. General discussion of existing situation, including types of cross-connections, epidemics attributable thereto, legislation, and protective measures and devices. —*R. E. Thompson (Courtesy Chem. Abst.).*

Storage Dam Recommended to Control Upper Potomac. Eng. News-Rec., 113: 360–1, September 20, 1934. To relieve gross pollution of Upper Potomac River and to increase water available for industrial use during periods of low streamflow, recommendation has been made by engineers retained by Upper Potomac River Board for construction of 155-foot earthfill dam on Savage River, one of its tributaries. Proposed dam would impound about 6.5 billion gallons and would make possible five-fold increase in dry weather flow, i.e., to 60 m.g.d. Numerous municipalities and several large industries are dependent upon Upper Potomac both for water supply and for waste disposal. Estimated cost is $1,260,000, or $194 per m.g. stored. It is hoped to obtain federal funds in whole or in part for project.—*R. E. Thompson.*

Turkey Creek Water Project, Ponca City, Oklahoma. Eng. News-Rec., 113: 385, September 20, 1934. Five contracts were awarded in August for construction of new water supply for Ponca City: (1) cleaning of lake site; (2) earth dam, dike, and concrete highway bridges; (3) pipe lines (steel); (4) 10-m.g.d. rapid sand filter plant; and (5) motor-driven high service pumping unit. Unit prices given.—*R. E. Thompson.*

Pumping Station Layout Fosters Efficient Operation. G. GALE DIXON. Eng. News-Rec., 113: 330–4, September 13, 1934. New water supply system of Mahoning Valley Sanitary District, which supplies Youngstown and Niles, Ohio, consists of large impounding reservoir on Meander Creek, and 40-m.g.d. purification and pumping plant just downstream, about 2 miles from center of Niles and 7 from center of Youngstown. Each city is served by duplicate force mains from pumping station, with distributing reservoir in Youngstown and standpipe in Niles. Pumping plant, which is described in detail, serves both to lift raw water to filter plant when level in reservoir is too low, and to pump filtered water to the 2 cities. Upper 15 feet of reservoir storage can be drawn through purification plant by gravity. It is expected that this method of operation will be possible for number of years. Pumping equipment consists of 1 low-lift pump and 4 high-lift pumps, all electrically driven. Power is furnished under 20-year contract providing flat rate of 0.8¢ per kw.-hr. for first 10 years and 0.7¢ thereafter. Preliminary studies had shown that over period of 20 years, current would have to be purchased at 0.75¢ per kw.-hr. to make total expense of electric station just equal to steam station, with

coal at $3 per ton, delivered. Weighted average overall efficiencies of 4 high-lift units was 81.8 per cent, as compared with guaranteed weighted average of 80.7 per cent.—*R. E. Thompson.*

A National Water Policy in the Making. CAREY H. BROWN. Eng. News-Rec., **113**: 393–6, September 27, 1934. Discussion of work of Mississippi Valley Commission, originally appointed by PWA for consideration of requests for funds for flood control and allied projects in Mississippi Area, but later expanded to include general planning with reference to water conservation and control. Through a recent executive order of the President, committee has become water resources section of newly created National Resources Board and is charged with task of making inventory of water resources of entire country, with formulation of long-time plan for wise use of the same, and with provision for their coordination and control. Author points out that water resources in general are coming to be looked upon as national asset whose development must be considered from national point of view.—*R. E. Thompson.*

Water Resources Report Shows Need of More Data and Fuller Study. Eng. News-Rec., **113**: 340–1, September 13, 1934. Data are given from preliminary report upon development of nation's water resources, transmitted to Congress by the President on June 4. Under title, "Development of the Rivers of the United States," House Document No. 395, 73rd Congress, 2nd Session, contains the President's message of June 4, report of the President's committee on water flow, reports of technical advisory subcommittee on organization and policy, reports of several regional committees, and review of reports of regional committees by reviewing committee set up within Department of the Interior. The Cabinet Committee, in concluding its report, states that basis of comprehensive plan for water policy lies in (1) adequate facts, maps, and general information easily accessible and in comparable form; (2) continuous study and refinement of plans for full development of river basins with coördination of present agencies engaged in elements of the work; (3) agreement upon statement of principles to govern division of responsibilities and costs as among federal, state, municipal, and private parties, for various kinds of projects and combinations of projects; (4) agreement upon statement of principles to govern extent to which various kinds of projects shall be charged to users and on method of apportioning such charges; and (5) agreement upon statement of social, economic, physical, and geographical criteria for choice and priority of projects and units.—*R. E. Thompson.*

Inspecting and Recording Condition of Fire Hydrants. CARL A. HECHMER. Eng. News-Rec., **113**: 334, September 13, 1934. System employed in Washington Suburban Sanitary District is described. Data reported on field sheets are transferred to permanent record cards and, in addition, condition of hydrants, etc., is recorded on 600-foot scale map by means of colored pins, discs, and celluloid flags.—*R. E. Thompson.*

Designing a Water Supply for a Golf Course. PAUL E. GREEN and GEORGE L. OPPER. Eng. News-Rec., 113: 342–3, September 13, 1934. Major factors in design of water supplies for golf courses are discussed.—*R. E. Thompson.*

Reading Starts Work on New Water Supply System. Eng. News-Rec., 113: 323–6, September 13, 1934. Recent allotment by PWA of loan and grant of $2,550,000 has made possible active execution of comprehensive program of water supply improvement in Reading, Pa., consisting of: large impounding reservoir on Maiden Creek; pressure conduit from reservoir to new filter plant; rapid sand filtration plant having ultimate capacity of 40 m.g.d.; 60-inch filtered water conduit to filtered water reservoir; remodeling of existing slow sand filters for use for storage of filtered water; and reconstruction of Hampden Reservoir in city. At present time water is supplied to population of 120,000, some 7,000 residing outside city. Ontelaunee Dam, now under construction on Maiden Creek, will be earth structure, 2400 feet long, faced with riprap on upstream slope. Purification plant will consist of traveling screen, coagulation basin of labyrinth type, 3 sedimentation basins providing retention of 3.5 hours, 12 filters with rated capacity of 3⅓ m.g.d. each, and aëration basin containing 110 circular dripping-tray aërators.—*R. E. Thompson.*

Largest British Dam Completed in India. Eng. News-Rec., 113: 405-6, September 27, 1934. Mettur Dam, largest in British Empire, has been completed in southern India to provide 2,140,000 acre-feet of storage for irrigation and flood control, with supplemental power development. Features of structure, which is located on Cauvery River, are: maximum height, 230 feet above foundation; crest length, 5000 feet; volume of masonry and concrete, 2,000,000 cubic yards. Headwater areas receive average rainfall of about 200 inches per annum, with maximum of double that amount. Drainage area behind dam is 2300 square miles. Flood of 436,000 second-feet in July, 1924, exceeded by 74 percent the then-recorded maximum flow of 250,000 second-feet. Dam has gravity section with straight crest. Upstream face is of rubble masonry, set in special rich mortar, remainder of dam consisting chiefly of concrete. Construction was started in 1928.—*R. E. Thompson.*

Fines in Concrete. I. F. MORRISON. Eng. News-Rec., 113: 535-6, 1934. Brief discussion of article by LYSE (C. A. 28: 6971) in which it is pointed out that effect of clay in concrete depends on its relation to the other aggregate particles: loose clay has no detrimental effect, whereas clay adhering more or less firmly to the aggregates reduces strength of concrete.—*R. E. Thompson (Courtesy Chem. Abst.).*

Subaqueous Steel Pipe Line Lowered from Pipe Pontoons. WILLIAM C. CURD. Eng. News-Rec., 113: 170–2, August 9, 1934. New water supply system of Fort Wayne, Ind., replacing former ground water supply, consists of dam impounding water of St. Joseph River at northerly limits of city and 42-inch pipe line, 12,360 feet long, to filter plant located near business district at junction of St. Marys and St. Joseph Rivers. Subaqueous crossing of latter river, con-

sisting of 5 straight 40-foot sections and 2 elbow sections, was assembled and encased in 6 inches of concrete on bank and floated to position by means of pipe pontoons, which were later dismantled and used elsewhere in line. Pipe for entire line was fabricated with longitudinal welded seams. Except for 5 joints in subaqueous section and several at valve connections, field joints were of Dresser-type bolted couplings. Subaqueous joints were riveted, rivet heads and inside and outside girth seams being electrically welded to insure water tightness and strength.—*R. E. Thompson.*

Analysis of Boulder Dam Spillways made by Swiss Laboratory. E. Meyer-Peter and Henry Favre. Eng. News-Rec., 113: 520-2, October 25, 1934. Analytic and model study of Boulder Dam spillways, carried out in Hydraulic Research Laboratory, Zürich, Switzerland, is described and discussed. Results of model tests, made on 1:150-scale model, agreed very well with results of calculation by method proposed by Dr. Favre and described in bulletin of Hydraulic Research Laboratory.—*R. E. Thompson.*

Heat of Hydration of Cement by Simple Apparatus. William Lerch. Eng. News-Rec., 113: 523-4, 1934. The apparatus and procedure described by Pierce and Larmour (C. A., 28: 2867) have been modified so as to reduce the number of operations, shorten the time required, and, probably, improve the precision of results, which are shown to be in good agreement with those obtained with the isothermal calorimeter of the Bureau of Standards. Apparatus is simple and inexpensive.—*R. E. Thompson (Courtesy Chem. Abst.).*

Progress in the Control of Artesian Water Supplies. O. E. Meinzer. Eng. News-Rec., 113: 167-9, August 9, 1934. Although much artesian water has been wasted, it is not too late to introduce effective programs of conservation. Perhaps the two best examples of successful conservation are afforded by artesian basin of Honolulu and Roswell basin in Pecos Valley, N. M., where waste has been largely eliminated and rate of withdrawal is well under control, the long downward trend in artesian head having been arrested and distinct reversal registered. It has been demonstrated that artesian head will rise and reservoir will refill whenever rate of withdrawal is kept below rate of recharge. Conservation procedure and law relating to artesian water rights are discussed. Bibliography of 13 references.—*R. E. Thompson.*

Raising a Concrete Dam. Eng. News-Rec., 113: 386, September 20, 1934. Amongst improvements to water supply of Reading, Pa., old concrete gravity dam at Ontelaunee Reservoir will be raised 20 feet to form spillway for new earth dam under construction. Unit prices of bidders given.—*R. E. Thompson.*

Mechanical Filter Plant, Reading, Pa. Eng. News-Rec., 113: 482, October 11, 1934. Complete unit prices of 3 lowest bidders on 4 contracts awarded for construction of mechanical filter plant are given.—*R. E. Thompson.*

Well Points Supply Sea Water for Swimming Pool. H. W. COCHRAN. Eng. News-Rec., 113: 733, 1934. The water supply for a new open-air swimming pool at Fort Monroe, Va., is drawn from series of well points along the beach, water so obtained, which is non-irritating to the eyes, consisting of filtered sea water diluted with about 20 percent of fresh water. The rate of flow provides for a complete change of water every 7½ hours. Neither filtration or chlorination is necessary. To control algae, 5 pounds of copper sulfate are placed in a perforated tin in path of incoming water every 48 hours. Cost of operation is 50 cents per hour at night (owing to lighting) and 12 cents per hour during the day. High-silica cement was employed in construction of pool, owing to its hard resistance to attack by sea water, and has proved most satisfactory.—*R. E. Thompson (Courtesy Chem. Abst.).*

Lowering a Water Tank by Flame-Cutting the Tower Leg. Eng. News-Rec., 113: 502, October 18, 1934. Brief description of procedure employed in lowering 50,000-gallon, flat-bottom, wooden water tank on steel tower 60 feet high. Tank was lowered, for esthetic reasons, total of 20 feet by burning off each leg of tower 4 inches at a time.—*R. E. Thompson.*

Water Problem Mostly Rural in Central Drought Area. Eng. News-Rec., 113: 181–5, August 9, 1934. Hardships due to present drought have been confined largely to rural sections, very few municipalities being affected. Chief sufferers are small towns dependent on surface water impounded in reservoirs with small runoff areas. No large cities are threatened and no unusual health hazards are reported from depleted supplies. For first 5 months of this year, rainfall was but 40 percent of normal in Kansas and but 66 percent in Nebraska. Details of conditions resulting from drought are given.—*R. E. Thompson.*

Large Centrifugal Pumps on English Drainage Works. E. E. R. TRATMAN. Eng. News-Rec., 113: 399–402, September 27, 1934. Illustrated description of extensive drainage works of Middle Level Drainage and Navigation District in low-lying marsh or fenlands in eastern part of England. Much of drained land lies below sea level. Recently constructed outfall works at St. Germans include 3 pumping units, each consisting of horizontal centrifugal pump, geared to 1000-h.p., 8-cylinder, 4-crank, horizontal Diesel engine, capable of discharging 180,000 Imperial gallons per minute against static head of 10 feet. Impellers, or runners, are 96 inches in diameter, with 7-foot suction pipes on each side. Pumps are said to be largest of type ever constructed in England, if not in world.—*R. E. Thompson.*

Large Pumps in English Drainage Works. Eng. News-Rec., 113: 533, October 25, 1934. Statement that pumps of Middle Level Drainage and Navigation District are believed to be largest centrifugal pumps ever built (cf. previous abstract) is true only in so far as horizontal pumps are concerned. On Zuyder Zee drainage works in Holland there are 3 vertical-shaft centrifugal pumps with 99-inch runners and also two 69-inch horizontal-shaft pumps.—*R. E. Thompson.*

Orifice Limits Water Use While Bills are Unpaid. Eng. News-Rec., 113: 433, October 4, 1934. Simple and ingenious device, developed by WILLIAM COUDOUX, allows indigent consumers in Forest Park, Ill., to draw enough water for drinking and sanitary purposes and prevents use of large quantities. Metal disk with small hole is placed in one of unions near water meter and sealed. Orifice permits flow of about 1 gallon per minute. When bill is paid, disk is removed.—*R. E. Thompson.*

Removable Grade Hubs for Siphon Invert. Eng. News-Rec., 113: 344, September 13, 1934. Brief description of grade markers used in placing invert of concrete siphons along aqueduct being built by Metropolitan Water District of Southern California.—*R. E. Thompson.*

Cooling Boulder Dam Concrete. BYRAM W. STEEL. Eng. News-Rec., 113: 451–5, 1934. Cooling and grouting operations at Boulder Dam during 12-month period are reviewed in some detail. Cooling of mass concrete to control shrinkage is effected by circulation of (1) air-cooled water and (2) refrigerated water through a system of pipes buried in the concrete. Refrigeration plant has rated capacity of 825 tons and cooling pipe system is 571 miles in length.—*R. E. Thompson (Courtesy Chem. Abst.).*

Pump-Testing Program for the Colorado River Aqueduct. Eng. News-Rec., 113: 552, November 1, 1934. Tests are being conducted at California Institute of Technology with object of increasing efficiency of pumps for 5 stations to be built on aqueduct from Colorado River to Los Angeles. Individual pump capacities of 200 second-feet are being considered for total aqueduct capacity of 1500 second-feet. Maximum head, per single pumping lift, would be 440 feet, and aggregate lift of 5 stations about 1590 feet. Inprovement of 1 percent in pump efficiency is estimated to be equivalent to saving in pumping costs of $50,000 per annum. Metropolitan District has budgeted $88,000 for study. Size ratio of models used is 1:6.—*R. E. Thompson.*

Tunnel Invert Smoothed by Vibrated Screed. Eng. News-Rec. 113: 503–4, October 18, 1934. Brief description of screed used in smoothing invert of Fan-Hill concrete siphon in Colorado River aqueduct of Metropolitan District. —*R. E. Thompson.*

Computation of Floodflows by Slope-Area Method. A. H. DAVISON. Eng. News-Rec., 113: 244–6, August 23, 1934. Discussion of computation of flood flows from field observations, with particular reference to value of n, the coefficient of roughness.—*R. E. Thompson.*

Boulder Dam Cement and Concrete Studies. R. F. BLANKS. Eng. News-Rec., 113: 648–51, 1934. Data of more general interest obtained during extensive program of research on cement and concrete carried out by Bureau of Reclamation in connection with Boulder Dam project are summarized and discussed.—*R. E. Thompson (Courtesy Chem. Abst.).*

Groundwater in the Midwest Drought Area. O. E. Meinzer. Eng. News-Rec., 113: 495–8, October 18, 1934. Records will show that midwest drought is outstanding with respect to duration, areal extent, and intensity. Never before in weather history of United States has there been such deficiency in precipitation over so wide a territory throughout an entire growing season. Situation has been seriously aggravated by extremely high accompanying temperatures. Water supply conditions and problems in north-interior region, as affected by drought, are outlined, with special reference to geology of region, and it is shown that, next to weather itself, geological conditions are here the most important controls of water supplies in times of drought. The drought has emphasized value of ground waters, demonstrated value of systematic studies carried on for many years by federal and state geological surveys, and shown that much more intensive investigation is needed. Studies of ground water levels have shown that water table undergoes pronounced fluctuations from season to season and from year to year with changing weather conditions. Hydrographs of 2 observation wells near Washington, D. C., furnish evidence from which following important inferences may be deduced: (1) even before white men came into country, ground water levels were fluctuating, and hence concept of an original ground water level is essentially fictitious; (2) present low ground water levels in north-interior region are largely due to severe drought conditions of last few years; and (3) there will be recovery of ground water levels with recurring wet years. It appears that there is no reason to fear that there will be progressive lowering of water table in future except in areas of excessive pumping.—*R. E. Thompson.*

Changed Elevated Tank Design Required for Safety Against Earthquakes. A. L. Brown. Eng. News-Rec., 113: 424–6, October 4, 1934. Effect of earthquakes on elevated tanks is discussed and investigation being conducted at Massachusetts Institute of Technology is described, immediate objects of which are as follows: (1) to determine characteristic behaviour of elevated tank tower when subjected to ground motions of various periods and amplitudes; (2) to find how motion of water in tank affects stresses set up in tower by earthquake; and (3) to determine what relation, if any, exists between stresses actually produced by earthquakes and stresses calculated by commonly accepted methods of anti-seismic design. Study, thus far, has shown definitely that present method of assuming static application of force is considerably on unsafe side. Moderate strengthening of tower may have no beneficial effect on earthquake resistance unless rigidity can be increased to give natural period of not more than one-tenth of that of usual tank structure, which may be from 1 to 3 seconds. It appears to be logical conclusion, therefore, that economical solution will require departure from present design. Study is being continued.—*R. E. Thompson.*

Japan Completes Long Tunnel After 16 Years of Difficulties. Eng. News-Rec., 113: 534, October 25, 1934. Opening of 5-mile Tanna tunnel of Japanese Government Railways is scheduled for December 1. Project, which met with unprecedented combination of difficulties, was started in July, 1918. Geologic

faults, swelling and shattered ground, mud slides, and enormous quantities of water under high pressure were encountered and 2 severe earthquakes occurred during construction and about 70 lives were lost.—*R. E. Thompson.*

The Boulder Canyon Project a Fully-Planned Development. Eng. News-Rec., 113: 686–91, November 29, 1934. Discussion of economic aspects of project and of recent developments in regard to undertaking.—*R. E. Thompson.*

Placing 40-Ton Concrete Pipe in Little Morongo Siphon. Eng. News-Rec., 113: 526–7, October 25, 1934. Illustrated description of construction of siphon which will connect 2 tunnel portals of Colorado River aqueduct that overlook and are separated by Little Morongo Canyon. Total length is 723 feet and maximum head 118 feet. Section, about 400 feet long, at bottom of canyon is approximately level and west and east slopes are 45° and 37°, respectively. Concrete pipe sections, which were cast in canyon, are 12 feet in diameter and 12 feet long and weigh about 40 tons each. Excavation was done by dragline operated by locomotive crane on crawlers, same machine being used for placing pipe sections. Joints were of "Lock Joint" lead and steel type, outside being filled with cement grout and inside with mortar applied with cement gun. Concrete cradle supporting pipe over 90° arc was poured simultaneously on both sides of pipe. Specifications limited leakage to 15,000 gallons per mile of pipe per 24 hours, or about 104 gallons per inch diameter. Actual leakage in 24-hour test was 92 inch-gallons, much lower figure being obtained 30 days later, after standing full of water.—*R. E. Thompson.*

Tunnel Driving on Colorado Aqueduct Totals 33.8 Miles in Nine Months. Eng. News-Rec., 113: 511, October 18, 1934. Detailed data on driving progress on Colorado River aqueduct tunnels for Metropolitan Water District of Southern California from January to September, 1934. During this period, total advance in 55 headings was 33.8 miles, bringing mileage driven to date to about half the 91-mile total length of tunnels included in 241-mile aqueduct. Tunnels are 16 feet in diameter.—*R. E. Thompson.*

Welded Joints Studies with New Type Polariscope. Eng. News-Rec., 113: 621–2, November 15, 1934 Brief description of device, known as reflection polariscope, developed at Columbia University for photo-electric studies of problems involving 2 parallel systems of plane stress, as represented by stress distribution in overlapping plates of side-welded connections. Complete description was published in June, 1934, issue of Review of Scientific Instruments.—*R. E. Thompson.*

All-American Canal Project Started on 30-Mile Section. Eng. News-Rec., 113: 488–9, October 18, 1934. Work has been commenced on excavation of 40,000,000 cubic yards of material to complete first 30-mile section of All-American Canal, which will convey 10,000-second-foot supply of Colorado River water to Imperial Valley and Coachella Valley in extreme southeast

corner of California for irrigation, by route lying entirely within United States, in accordance with one of major provisions in Boulder Dam Act approved in 1928. Work is being carried out by Bureau of Reclamation for cost not to exceed $38,500,000, and federal government will be repaid over period of 40 years, without interest. Present project does not include 80-mile branch to Coachella Valley. Water will be diverted from Colorado at point about 5 miles above Laguna Dam diversion structure of Yuma project in Arizona. Canal capacity is 15,000 second-feet (about 70 percent of average flow of Colorado River at Boulder Dam) from diversion dam to Siphon Drop (15.5 miles), where 2,000 second-feet will be diverted into Yuma main canal. The 13,000-second-foot capacity is maintained from Siphon Drop to Pilot Knob, where 3,000-second-foot power diversion will be made, and 10,000-second-foot capacity is maintained westward for irrigation supply to Imperial and Coachella Valleys. Coachella Valley branch canal will have initial capacity of 1500 second-feet where it leaves main canal. City of San Diego is negotiating for 155-second-foot capacity in canal to augment present municipal water supply by conduit that would take off from west side of Imperial distribution system. —*R. E. Thompson*.

Denver Secures $3,500,000 PWA Loan to Build Water Supply Project. Eng. News-Rec., 113: 640, November 15, 1934. Project will bring water from western slope of continental divide through pioneer bore of Moffat tunnel to augment Denver's water supply by 54,600 acre-feet annually. City owns rights in Fraser River. Water will be diverted to eastern slope and ultimately reach South Platte River below Denver, where it will be exchanged with owners of prior rights above Denver so that equal supply will become available for municipality.—*R. E. Thompson*.

Tidal River Silt Movements from Rotterdam to the Sea. GEERT BLAAUW. Eng. News-Rec., 113: 623-5, November 10, 1934. Review and discussion of work of J. J. C. CREMERS on Maas River. It was found that, in estuary of Maas, rate of flocculation of material in suspension was controlled by rate of mixing of salt and fresh water in flood basin. Spur dikes, after considerable experimentation, have proved successful in eliminating enormous amount of ceaseless dredging. It is suggested that coastal currents that often run at right angles in neighborhood of estuaries during change of tides might be given injector action by means of submerged dikes, thus carrying far into sea the cloud-like masses of silt and sand.—*R. E. Thompson*.

Parker Dam Being Built for Metropolitan Water District. Eng. News-Rec., 113: 692, November 29, 1934. While Parker Dam is part of Colorado River aqueduct system of Metropolitan Water District of Southern California and was to have been built and paid for by district, it is now being built by United States Bureau of Reclamation to avoid controversy between states over right of California to enter Arizona to build dam (site being on interstate border). Title of dam is to remain with federal government. Under terms of contract between Bureau and District, government is to have right to one-half power

privilege and District the right to other half for pumping water into aqueduct. Dam is located about 150 miles below Boulder Dam and will form pool from which water will be pumped into aqueduct. Dam will be most unusual in that while it will raise water surface only 85 feet, main body of dam will have total height of 320 feet from bottom to roadway on crest due to detritus overlying sound rock in river gorge. Structure will be of concrete-arch type, about 800 feet long on crest. River will be diverted through two 29-foot horseshoe-shaped tunnels and site will be unwatered behind earthfill cofferdams. Total cost, including power house, penstock tunnels, etc., is estimated at $13,000,000.—*R. E. Thompson.*

Welding and X-Raying the Boulder Dam Penstocks. Eng. News-Rec., **113**: 628-30, November 15, 1934. Illustrated description of fabrication and inspection of penstock pipes for Boulder Dam power houses, now 50 percent completed. Plates are welded by automatic-fusion method and entire 400,000-foot length of welded joints is to be X-rayed. Diameter ranges from 13 to 30 feet and plate thickness from $\frac{3}{4}$ inch to $2\frac{3}{4}$ inches, largest sections weighing 170 tons each. Welding and X-raying procedures are outlined and illustrated. After completion of all operations in welding shop, including approval of X-rays on rewelds, each pipe section is treated in annealing furnace to relieve internal stresses.—*R. E. Thompson.*

Dam Stresses and Strains Studied by Slice Models. J. L. Savage. Eng. News-Rec., **113**: 720-3, December 6, 1934. Testing of models of maximum cantilever sections or slices of several dams (Boulder, Grand Coulee, and Norris) by United States Bureau of Reclamation described and discussed.—*R. E. Thompson.*

Bulk Cement Pumped a Mile. Eng. News-Rec., **113**: 811-3, December 27, 1934. Cement for Boulder Dam (total quantity about 4,500,000 barrels) is delivered in carload lots at Boulder City, contractors moving cars from that point to high-level plant on northerly rim of canyon, where cement is unloaded, stored, blended, and pumped pneumatically to bins over each of mixing plants. High-level plant is close to blending plant: low-level plant is some 5420 feet distant and at level about 500 feet lower. Cement is unloaded and transported between plants through 9-inch pipe line by compressed air pumping. Two pumps were provided in 5420-foot line, but 2nd pump, near midpoint of line, has been found unnecessary. Details of installation are given.—*R. E. Thompson.*

Rapid Development of Diesel Engines. J. L. Busfield. Eng. and Cont. Record, **48**: 1088-9, December 26, 1934. Brief historical outline.—*R. E. Thompson.*

Long-Range Planning Advocated by National Resources Board. Eng. News-Rec., **113**: 796-7, December 20, 1934. Abstract of Part 1 of report of National Resources Board submitted to the President on December 1. In regard to

water resources, permanent water planning section is proposed, with following functions: (*a*) to assemble promptly such basic data needed for planning and use of waters as now exist in scattered places, and initiate research to provide necessary additional data; (*b*) to proceed, as rapidly as is compatible with thoroughness, to develop constructive programs for use of country's water resources in public interest, and for safeguarding that interest against dangers threatened by water; (*c*) to make fullest use feasible of specialized knowledge and experience possessed by existing public agencies, municipal and state, as well as federal; and (*d*) to investigate water pollution in all its phases, including effect of pollution on fish and on other forms of aquatic life and on organisms. Seventeen projects are recommended for detailed study by present water planning committee.—*R. E. Thompson.*

State Water Authority for New Jersey Recommended by Water Policy Commission. Eng. News-Rec., 113: 838, December 27, 1934. Centralization of responsibility for water supplies of New Jersey through creation of "New Jersey Water Authority" has been recommended by State Water Policy Commission in report to Governor. Report further recommends that, coincident with creation of the Authority, (*a*) the State Water Policy Commission be discontinued, (*b*) the North Jersey District Water Supply Commission remain only as agent of municipalities interested in the Wanaque, to complete and operate that system; and (*c*) the construction powers of Passaic Valley Water Commission, as applied to new sources, be transferred to Authority. Purpose of recommendations is to center responsibility for planning, development, and operation of adequate supply for all parts of state. Authority would furnish water at wholesale rates to municipalities served and latter would distribute to local consumers. Water supply problem of numerous communities in northeastern part of state is discussed. Recommended that control of sewage be not consolidated with control of potable water systems.—*R. E. Thompson.*

Diesel Engine for Water Works Standby Unit at St. Stephen, N. B. Eng. Cont. Rec., 48: 1037–8, December 12, 1934. Brief description of new standby Diesel-engine-driven pump installed in the St. Stephen electrically-driven pumping station. Pump is 2-stage centrifugal unit with 10-inch suction and 8-inch discharge, rated at 1500 gallons per minute, against 156-foot head and at speed of 1000 r.p.m. Guaranteed efficiency of 85 per cent was exceeded in shop test. Pump is direct connected to Ruston type "6VQ" 6-cylinder Diesel engine of cold-starting, airless injection type, capable of delivering continuous rating of 106 b.h.p. at 1000 r.p.m. Fuel cost is $0.0056 per b.h.p. per hour, oil consumption being 5 gallons per hour at 12¢ per gallon.—*R. E. Thompson.*

A Concrete Gravity Dam for a Faulted Mountainous Area. Samuel B. Morris and Cecil E. Pearce. Eng. News-Rec., 113: 823–7, December 27, 1934. Morris Dam, a 328-foot, concrete, gravity-section structure on San Gabriel River, presented several unusual design problems: (1) fault that crossed site; (2) unusually large outlet capacity for streamflow regulation; and

(3) spillway in difficult location. During construction period, structure was known as Pine Canyon Dam. Reservoir formed will store 39,300 acre-feet of water to supplement present domestic water supply of Pasadena, obtained from deep wells. Permits, granted city by California Division of Water Resources, allow storage and diversion of such quantity only of water as actually would, under natural conditions of unregulated streamflow, waste to sea. City is therefore compelled to release: (1) all water heretofore diverted from surface streamflow; (2) natural underflow and low-water flow at dam site; and (3) all water that would naturally percolate into ground in river channels between dam and sea. Dam was designed to resist earthquake shock with acceleration of one-tenth of gravity. Agreement has been made with Metropolitan Water District of Southern California to sell dam and reservoir, for district's use in storing Colorado River water when that supply is available for distribution in Pasadena. Water is conducted to city through 18.5-mile, 36-inch, welded steel pipe line. Development of dam design and appurtenant works is reviewed and discussed.—*R. E. Thompson.*

Groundwater Cut-off Wall Provides New Water Supply. A. B. McDaniel. Eng. News-Rec., **113**: 757–9, 1934. Water supply of Harrisonburg, Va., derived from the Dry River, was inadequate during drought of 1930 and has been supplemented by construction of ground water system consisting essentially of concrete cut-off wall, or dam, about 900 feet long, to intercept underflow in valley of the river, collecting gallery above the wall, and pipe line to the existing supply mains. About 12 large underground streams were encountered across the valley. Cost of the project was $37,567.—*R. E. Thompson (Courtesy Chem. Abst.).*

Progress in Sanitary Engineering Undertakings. A. E. Berry. Eng. Contract Record, **48**: 1096–1100, December 26, 1934. Developments in Ontario are reviewed and discussed.—*R. E. Thompson.*

Prospects for Water Works and Sewerage Undertaking in Quebec. Réné Cyr. Eng. Contract Record, **49**: 17–21, January 9, 1935. Projected works are described.—*R. E. Thompson.*

Distribution of Gasket Pressure in Pipe Joints and Clamps. George H. Pfefferle. Eng. Contract Record, **48**: 711–3, 758–61, 1040–3, August 22, September 12, and December 12, 1934. Inadequacy and inaccuracy of existing methods of determining gasket pressures and need of accurate measurements for intelligent design of pipe joints prompted development of entirely new and extremely accurate gasket pressure gage, a flow detector for indicating leakage (using gas for leakage tests) and small variations in line pressure, and an accurately calibrated torque wrench for uniformly loading bolts of clamps and joints under test. This equipment, results of measurements on joints, and the improvements accordingly introduced are described and discussed. Tests showed that losses of gasket pressure practically all occur during first 3 weeks after installation, subsequent changes being unappreciable. New

type of gasket has been developed, essential feature being metallic armor in form of closely coiled helix which is practically indestructible and yet as flexible as gasket material itself.—*R. E. Thompson.*

Broad Development Plan Proposed by Mississippi Valley Committee. Eng. News-Rec., **114**: 19–21, January 3, 1935. Data are given from report on Mississippi River Basin by Mississippi Valley Committee of PWA, including specific recommendations. Object of committee, now re-constituted as Water Planning Committee of National Resources Board, was formulation of plan for use and control of water within Mississippi drainage basin, that vast area comprising all or part of 31 states. Report states that during next 20 years, government could profitably spend one billion dollars on river works in Mississippi Valley, 50 per cent of which would be self-liquidating. Regarding water supply and sanitation, report emphasizes need for uniform state legislation and for cooperation between state and federal agencies in collection of data, and in establishment of water supply and sewage disposal districts.—*R. E. Thompson.*

A Regional Development Project of Pioneer Days. M. N. Baker. Eng. News-Rec., **114**: 45–9, January 10, 1935. Historical outline of activities of SUM, Society for Establishing Useful Manufactures, founded by Alexander Hamilton in 1791 and closely associated with development of water supply of northeastern New Jersey.—*R. E. Thompson.*

Use of Wood-Stave Pipe in Russia Has Advanced. A. Popkow. Eng. News-Rec., **114**: 52–3, January 10, 1935. As result of shortage of metal and search for substitute for same, use of wood-stave pipe has developed rapidly in Russia, production in 1934 being estimated at 10,000,000 linear feet. Prior to 1927, there was no wood-stave pipe in Russia. Pipe is constructed chiefly of pine, although larch is used to limited extent and fir has been used in rare instances. Both continuous and machine-banded types of pipe are being produced. Typical installations are outlined briefly and illustrated.—*R. E. Thompson.*

NEW BOOKS

Doucil for Softening Water. American Doucil Co., Philadelphia, Pennsylvania. 38 pp. From Chem. Abst., **28**: 4514, July 20, 1934.—*R. E. Thompson.*

Boiler Feed and Boiler Water Softening. H. K. Blanning and A. D. Rich. Chicago: Nickerson and Collins Co. 156 pp. $3. From Chem. Abst., **28**: 4812, August 10, 1934.—*R. E. Thompson.*

Wasser- und Bodenanalyse. Heinrich Preissecker. Leipzig: F. Deuticke. 27 pp. From Chem. Abst., **28**: 4812, August 10, 1934.—*R. E. Thompson.*

Die Stadtentwässerung in Deutschland. Edited by Josef Brix, Karl Imhoff and R. Weldert. Bd. I. 972 pp.; Bd. II. 600 pp. Jena: G. Fischer. M. 138. From Chem. Abst., **28**: 4812, August 10, 1934.—*R. E. Thompson.*

Hydrographie. FRIEDRICH SCHAFFERNAK. Paper; 7 x 10 in.; pp. 438. Vienna: Julius Springer. RM 46.50. Reviewed in Eng. News-Rec., **114**: 921, June 27, 1935.—*R. E. Thompson.*

The Work of the Sanitary Engineer. ARTHUR J. MARTIN. MacDonald and Evans, London. 472 pages, 81 Illustrations. From long association, we have come to expect text books on engineering matters to be strictly technical or theoretical in dealing with this subject. Whether this is the result of the engineer's point of view, or the cause of it, is, for the purpose of this review, immaterial. Suffice it to say that much criticism is being launched at the engineer for his lack of knowledge or understanding of the problems of law and of public administration, relating to the practice of engineering. Here is a book which attempts to remedy this condition.

Mr. Martin states that he intended the book as a general text on the field of sanitary engineering. As such, he has done a good job, covering as thoroughly as is possible in one volume the subjects of water supply, sewerage and sewage disposal, and garbage and refuse collection and disposal. A brief section also deals with flood control and drainage. The author did not attempt to deal, however, with methods of construction with respect to sanitary structures.

Not being satisfied with mere discussion of the theory and practice of sanitary engineering, however, Mr. Martin has introduced general chapters on local and national government and on public laws relating to sanitary engineering. In addition, each section of the book is prefaced with a brief discussion of the public laws immediately related to the subject. This is an entirely new approach to engineering. For this reason alone, the book should be of value, not only to instructors, but to practising engineers, public health officials and public administrators.

Because of the fact that the book is limited almost entirely to English practice, it cannot be recommended as a text for American students. It should, however, be of much interest to graduate and advanced students and should unquestionably be of much assistance to the instructor who is interested in adapting his course to the point of view of the public administrator. Public officials and health officers generally will find much of value in it.

This book should inspire the writing of a similar treatise on American practice, suitable for the student or the practicing official in this country.—*Melvin E. Scheidt.*

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The reason for the initial high delivery capacity of Transite Pressure Pipe is obvious . . . it is given a smooth interior wall by the highly polished steel mandrel on which it is formed.

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Transite Pressure Pipe is made from asbestos and Portland cement. It is *non-metallic*. It simply *cannot* tuberculate.

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To fully appreciate the significance of Transite's unvarying C, check the figures on increase in pumping costs due to tuberculation through five, ten, fifteen, and twenty years of service. You'll find that it costs practically twice as much to pump against a coefficient of 100 as against a coefficient of 140.

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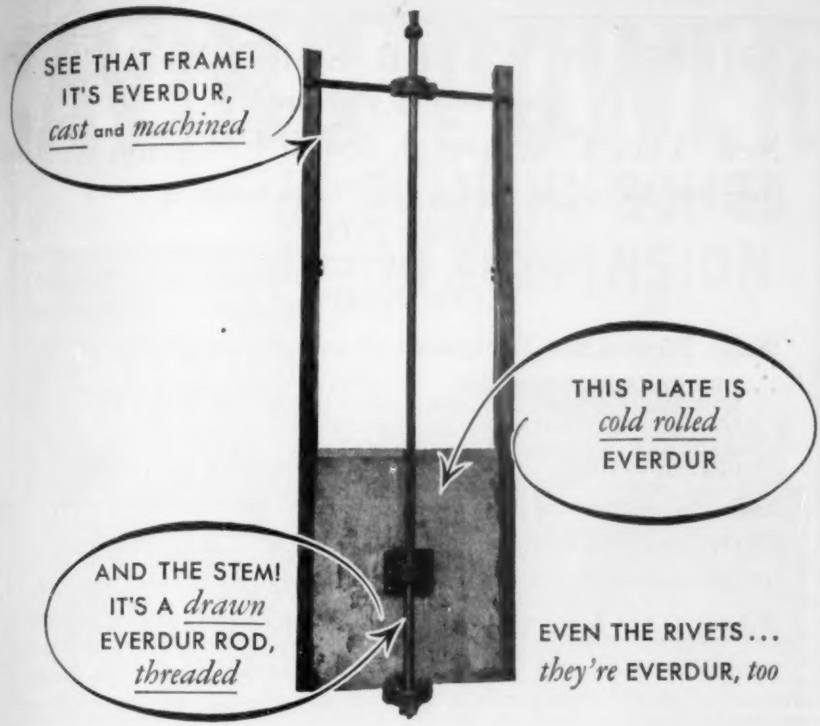

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COMING MEETINGS

December 27, 1935—New York Section—Hotel New Yorker, New York, N. Y. Secretary, R. K. Blanchard, Neptune Meter Co., 50 W. 50th St., New York, N. Y.

March 23–25, 1936—Kentucky-Tennessee Section—Lexington, Ky. Secretary, F. C. Dugan, State Board of Health, 532 W. Main St., Louisville, Ky.

April 1–3, 1936—Canadian Section—Hamilton, Ont. Secretary, A. E. Berry, Ontario Dept. of Health, Parliament Bldgs., Toronto, Ont., Canada.

April 7–9, 1936—Southeastern Section—Hotel De Sota, Savannah, Ga. Secretary, W. H. Weir, State Board of Health, State Capitol Bldg., Atlanta, Ga.

April 7–9, 1936—Indiana Section—Purdue University, Lafayette, Ind. Secretary, J. A. Bruhn, Box 855, Indianapolis, Ind.

April 17–18, 1936—Montana Section—Butte, Mont. Secretary, H. B. Foote, State Board of Health, Helena, Mont.

May 14–16, 1936—Pacific Northwest Section—Aberdeen, Wash. Secretary, E. C. Willard, 720 Corbett Bldg., Portland, Ore.

June 8–12, 1936—Annual Convention of American Water Works Association—Hotel Biltmore, Los Angeles, Calif. Secretary, B. C. Little, 29 W. 39th St., New York, N. Y.


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TH ANNUAL CONVENTION, LOS ANGELES, CALIF., JUNE 8-12, 1936

VOL. 27, NO. 12 DECEMBER, 1935

PROCEEDINGS 53RD YEAR

JOURNAL
OF THE
AMERICAN WATER WORKS ASSOCIATION

PUBLISHED MONTHLY
BY THE
AMERICAN WATER WORKS ASSOCIATION

SECRETARY'S OFFICE, 29 WEST 39TH STREET, NEW YORK
EDITOR'S OFFICE, 2411 NORTH CHARLES STREET, BALTIMORE, MARYLAND

Subscription Price, $7.00 per annum

THE MEANEST FIRE-BUG

Shuts Off Water Before Starting Fires

The villain of this story is mean, bitter, and completely heartless, but so clever and tricky as to be difficult to stop. The innocent victim is the whole population—everybody everywhere who is threatened by winter fires. And *you* are the hero, the one person who can do something about it. . . . Zero weather is the meanest fire-bug. Zero weather shuts off the water at the very moment it is starting fires.

You know winter's dirty work. You know how its icy grasp closes on operating threads, blocks standpipes, and heaves hydrants loose from the mains at the very moment when furnaces are being pushed beyond their limits, when fires in buckets are warming the poor, and when alarms are ringing in from all sides.

When this happens, your department is faced with a life-and-death crisis. Then it is too late to prevent the damage, the loss, the helpless standing by.

The time to face that problem is right now. . . . Give your citizens hydrants that will not freeze. Beat winter before it starts. Buy no hydrant unless its standpipe is free from standing water, its operating threads protected from moisture, and the whole hydrant guarded against the thrust of frozen ground. Then—and only then—will you have a sure flow of water whenever fire strikes. . . . Study the Mathews Hydrant with winter in your mind. Note its positive and automatic drain valve, which must be open when the hydrant is closed, and which drains a properly set hydrant almost instantly. Look where its operating threads are located, sealed in a dry chamber where neither pressure from the main nor water from outside can freeze them together. Look especially at its loose protection case, free to slide up and down with the frost-heaved movement of the ground, but with never a strain on standpipe, valve, or main. . . . The Mathews Hydrant is a good hydrant because it is a winter hydrant. The construction which makes it absolutely safe against frost also makes it ideal for Summer. It is double-strong, permanent, and fool-proof.

Remember, also, that the Mathews protection case construction gives you a hydrant which can be unscrewed and completely lifted from the ground, overhauled, inspected, repaired if broken, or replaced—all with no digging whatever. Once the Mathews Hydrant is in the ground, you will never use a shovel on it again.

Study your hydrant problem as a winter problem. Write for cross section views. Or, we'll be glad to show a perfect model, indicating exactly how the Mathews works. Would that help persuade your council? We'll send a man.

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Published Monthly at Mount Royal and Guilford Avenues, Baltimore, Md.
Entered as second class matter April 10, 1914 at the Post Office at Baltimore, Md., under the Act of August 24, 1912. Accepted for mailing at a special rate of postage provided for in section 1103 Act of October 3, 1917, authorised August 6, 1918